SB8001 **BUILDING INFORMATION MODELING** **L T P C**
1 0 2 2

PRE-REQUISITE
Basic knowledge about isometric structures and Engineering Graphics fundamentals are preferred

COURSE LEARNING OBJECTIVES
To enable learners to understand the concept of Building Information Modeling and application of the same in the life cycle of the project.

KEY JOB ROLES
- BIM Manager
- BIM coordinator
- Design Team Leader
- Design Engineer
- Design Manager

OVERVIEW
In this course, learners will be guided through each of the major project stages, from the strategic definition of the project right through to handover, operations and end of use. At each stage, the trainer will demonstrate how to balance technical requirements with project management skills, so the students are confident in implementing BIM methodology. The course covers the key skills and competencies required for implementing BIM-Building Information Modelling to AECO-Architecture, Engineering, Construction & Operation projects

UNIT I EVOLUTION OF ENGINEERING, INTRODUCTION TO BIM CONCEPTS AND DESIGN AUTHORING 3T+6P

Evolution of Engineering from 2D drawings to BIM Model, BIM Model of various projects like commercial & residential structures, Water Treatment Plant and Substation, Transportation
Isometric View – Introduction to Isometric Drawings, Creation of isometric views from different 2D views and vice versa: example problems, Limitation of Isometric views and concept of 3D-Modeling
Building Information Modeling – Introduction & Process
Design Authoring – Concepts and workflow, Fundamentals of Discipline Based Modeling, Introduction to stages of BIM Modeling process as per ISO 19650- Architectural, Structural, MEP (HVAC, Electrical, Plumbing), WIP stage of ISO 19650, Shared stage concept, Interdisciplinary based modeling, Federated model- Introduction. concepts and demonstrations, Concept, and workflow of design coordination
Engineering Analysis – Concept and types of analysis, Workflow of structural analysis, energy analysis, lighting Analysis, Process and workflow of Design Review in BIM.

UNIT II VISUALIZATION AND INTERFERENCE/CLASH CHECK 3T+6P
Views in BIM Model- plan, section, elevation, 3DVisualization Modes- Concept and viewing rendered, shaded, wore frame and hidden line mode, Walkthrough of the Model, Fly through the model
Layers & Properties, Concept of viewpoints, Sectioning and Visualization through Tablet and Mobile
Concept of BIM Kiosk & BIM Rooms, Visualization through Augment Reality (AR), Virtual Reality(VR) & Mixed Reality (MR)
Clash Check, Types of Clashes- Hard Clash & Soft Clash, Federated Model - Clash avoidance process, Clash Detection Process –Introduction, Clash Detection - Priority Matrix and Report generation, Clash Detection – Rules, Report, Grouping, Clash Detection - Roles & Responsibilities, Clash Detection Process – Demo.

UNIT III DOCUMENTATION & CDE & LEVEL OF DEVELOPMENT 3T+6P

Documentation and CDE (Common Data Environment) -2D drawings generation from BIM Model, Computer Network types, Concept of Cloud Computing, Concept and Application of CDE: Traditional Information Sharing, Definition, Reference, and Concept, Setting up the workflow and process for CDE- File naming convention, Roles and Responsibilities, Request for Information and Review Process

Concept of LOD (Level of Development), preparation of LOD matrix and Progression matrix- Definition of LOD, Level of Detail and Information, LOD- Wall foundation, Precast Structural Inverted T-Beam, Domestic Water Piping, Plumbing Fixture, Packaged Generator Assembly, LOD- Chart, Matrix and Model Progression Matrix

UNIT IV 4D / FIELD BIM & ITS APPLICATIONS 3T+6P

Introduction to 4D / Field BIM: Concept of 4D, Introduction to construction sequence and project schedule, Project scheduling using Gantt Chart and its limitation, 4D BIM Modeling-Project demo and workflow, Synchronization of 4D BIM Model with project schedule, Reviewing project progress w.r.t planned dates and actual dates, Generation of Reports

Application of Field BIM/ 4D BIM: Understanding concept and usage of BIM in field for coordination- 3D Coordination and Visual Communication, Site utilization planning and Construction analysis, Application of wearables in coordination. 3D Control and planning

Other Applications of Field BIM/ 4D BIM: Concept and usages of BIM in field for safety, disaster and risk analysis, digital fabrication and scan to BIM, Existing Condition Modeling, Phase Planning, As-built/ Record Models

UNIT V 5D BIM, AIM & BEYOND BIM - EMERGING TRENDS 3T+6P

5D BIM: Introduction concepts of 5D BIM, Quantity take off with UoM, Concept of QTO with UoM, 5D BIM with UoM with cost, Quantity take off exercise, Demo of Quantity take off: Understanding QTO for Wall, Plaster & Tile, BIM Maturity LOD and General Practice of QTO, Cost Breakup structures, 5D BIM and cost control

AIM: Introduction to Asset Information Model (AIM), COBie structures and Asset Information Deliverables, Space Attributes and Asset Attributes- Examples with data, Asset requirement- Discipline wise Infrastructure System, Classification code and Information Exchange, Information Exchange with Facility Management

Beyond BIM: Emerging Trends- Concepts of Industrialisation, IoT, Big Data, Data Analytics and their applications in BIM: Industrialisation of Construction through BIM- DfMA, IoT in BIM, BIM and Big data, Data Analytics using AI & ML

Future scope of BIM Applications: Smart Infrastructure and the need for connected infrastructure, Digital twins- Concepts and benefits, National Digital Twin or a City level Digital Twin in a Smart City, Fundamental requirements for the success of a Digital Twin and its uses, Digital Twin applications in diverse industries.

TOTAL: 45 PERIODS

BIM model of various buildings like residential, commercial and industrial with all possible clashes shall be be provided by us

CASE STUDIES

- BIM model of multi-storey building structure
- BIM model of airports
- BIM model to study site utilization
- BIM model of material handling unit
- On site super imposition of BIM model
- 5D BIM- Implement strategy for a building

ATTAINMENT OF LEARNING OUTCOMES

STUDENT ASSESSMENT PLAN

A. The conceptualisation and comprehension level of learning outcomes intended through the course is measured through assessments conducted in multiple stages.

B. The understanding of concepts & principles, evolution of practices, codes & guidelines, emerging trends etc. are tested through assessment questions.

C. The skill outcome related to design, computation, workflow, report & work plan preparation, implementation etc. are assessed through assignments. Such assignment questions & answer keys will be shared to the college SPOC for enabling evaluation by respective faculties.

STUDENT ASSESSMENT 1:

Students will have to create a clash detection matrix and analyse the clash report for a given BIM model of residential building.

STUDENT ASSESSMENT 2:

Students will have to create a clash detection matrix and analyse the clash report for a given BIM model of industrial/Commercial building.

SOFTWARE EXPOSURE

In this course BIM models of various industries such as shipping, airports, residential & commercial structures, water & sewage treatment plant, substation etc. are shown which were developed using software such as Revit, Civil 3D, Tekla, Aveva etc.

These software companies provide free access to students & educators for academic &research purposes.

For these structures the federated model including the field BIM application is shown using the software Navisworks, Synchro & Fuzor.

COURSE OUTCOMES

On completion of the course, the students will be able to perform the following operations for any one of the given BIM models.

- LO.1: Create a workflow for a building with all required deliverables to be covered in the project output.
- LO.2: Create the clash detection matrix for the federated structural, architectural and specialist designer project model.
- LO.3: Coordinate different discipline models with clash checking to arrive at the final design solution, inclusive of the deliverables from the model at each stage.

SB8002 TRANSPORTATION INFRASTRUCTURE – AIRPORTS, METROS & SEAPORTS

L	T	P	C
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PRE-REQUISITE

- Fundamentals of Highway and Railway engineering, Soil Mechanics, Structural analysis is preferable

COURSE OBJECTIVES:

- This course will present the concepts on the design aspects and knowledge on the construction methods of transportation infrastructure. It will provide exposure to the field and serve as base for future practitioners in the field of transportation engineering. The course facilitates the learners to involve in engineering works related to Airports, Metro & seaports planning, design, and construction.

KEY JOB ROLES

- Design engineer
- Site planning engineer
- Construction engineer

OVERVIEW

This course will provide the learner with an overview of major functions involved in the transportation infrastructure such as Metros, Airports & seaports. It will provide a roadmap for learners to understand the concepts involved in Civil, Structural, Architectural & MEP functions for Planning and Design Transportation infrastructure. These concepts are reinforced with demonstrations and real case studies/projects that have been successfully carried out in major cities in India and Abroad. It provides brief knowledge to the learner to steer through their career in the field of transportation engineering. The course also provides insights on the future modes of transportation, to supplement the learner to stay adept amidst the rapid advancement of technology in this field.
Learners are expected to gain knowledge on the design concepts of different structures and their constructability aspect related to transportation infrastructure.

UNIT I INTRODUCTION AND PLANNING OF MASS RAPID TRANSIT SYSTEM (MRTS) 3T+6P

Introduction - Overview of Metro, Transit Oriented Development, Necessity and Feasibility Study for MRTS Project, Sustainable and Smart Technologies, Recent Advancements & Future Technologies - Automated Guideway Transit Systems, Suspended Railway / Monorail, High Speed Rail, Semi High-speed Rail, Maglev Trains, Vactrain History, Development and Technology
Planning – Alignment Basic Interfacing Principles, Urban level planning constraints and restrictions, Planning of the Station, Integration of systems, HVAC Systems, Tunnel Ventilation System, Fire Protection System, Public Health Engineering, Electrical System, Fire Alarm System, Building Information Modelling (BIM) Walkthrough Contracts and Quality system - Introduction to Contracts, Overview of FIDIC standards, Introduction to Quality Systems.
Overview of Elevated metros – Alignment/ Span configuration of elevated structures, Superstructure, Substructure and foundation of elevated metro, Bridge articulation based on profile alignment
Overview of Station – Station overall layout, Station foundation, substructure and Pier arm
Construction Methods - Challenges in Metro Construction, Precast and cast in-situ construction, Precast yard and Mould development, Precast Erection and Launching methods, Overview of Obligatory Span overview, foundation construction methods

UNIT II ANALYSIS AND DESIGN OF ELEVATED AND UNDERGROUND STATIONS 3T+6P

Elevated station and Viaducts – Overview and components, Loads and load combination according to IRC/IRS Codes, Modelling, Analysis and Design of superstructure, Substructure and foundation of Viaduct, Idealization of Framed Station and Cantilever station, Design and analysis of platform slab, track slab and above ground structures, Spine beam method, Ductile detailing of structures, Introduction to Modelling Software - STAAD Pro and Midas Civil

Earth retaining structures – Types of Earth retaining structures, Diaphragm wall Analysis and design, Shoring Systems, Secant pile wall design, Guide walls, capping beams, supporting systems, Tunnels - Mined/Bored/NATM

Underground Stations – Configurations of underground station, Loads and load combination according to IRC/IRS Codes, SIDL for UG stations, Construction Methodology (Bottom-Up method/ Top Down method), Fire resistant criteria and Floatation check, 2D & 3D model generation, SOD restrictions & Element sizing for UG Stations, Design of all the components of UG station.

UNIT III INTRODUCTION AND TYPICAL MASTER PLANNING OF AN AIRPORT 3T+6P

Introduction - key features of a modern airport, Codes and aviation regulation organizations, Growth Requirements and Passenger Demand Capacity, Overview of existing and future Indian Airports

Outline of Master Planning process according to ICAO and FAA Planning and Design of Airside works – Topography and geotechnical investigation for green field airport and upgradation of existing airport, Survey of various elements/facilities, Layout plans, Configuration and orientation of runways, Design of Runway, Taxiway, Apron, Drainage System and Ducts

Planning of Terminal Building – Functions of Terminal building, Building Information Modelling (BIM) walkthrough, Facilities and services of terminal building: Passenger conveniences, Travellators, Departure and Arrival gates, MEP and HVAC Services etc.,

Planning of Landside works – Planning of Approach roads to Terminal building, Landside access for Arrival/Departure Planning, Multi- Level/Surface car parking/Waiting areas, Air Traffic Control Tower, Drainage Planning, arboriculture, Water harvesting cum storage/distribution, Fuel storage and supply, Power supply and Renewable Energy, Airport fire & Rescue station

UNIT IV CONSTRUCTION AND MAINTENANCE OF AIRPORT AIRSIDE WORKS 3T+6P

Pre-construction activities - Statutory Approvals, mobilization of key resources and Estimation of requirement of Plant and equipment - Earthmoving Plants, Dumpers and Compaction Equipment, Hoists and Tower Cranes

Construction of Runways and Taxiways - Airport Layout and Grading Plan, Execution and Estimation of various Layers of Flexible Pavements and Rigid Pavements, precast and cast in-situ drainage and duct, Navigational and Meteorological aids - Marking, Lighting, Instrument landing system and stations, etc., Maintenance, Evaluation and Rehabilitation of Runways and Taxiways - Evaluation of runways and taxiways, Causes & Typical Failures of Flexible and Rigid Pavements, Maintenance, Strengthening and Rehabilitation of Pavements, Discussion on pavement repairs

UNIT V OVERVIEW OF PORTS AND HARBOURS 3T+6P

Introduction and Evolution of Ports and Harbours, Classification of Ports, Overview of Indian Seaports

General Terms and Conventions – Waves and Tides, Tidal Variations, Return Period, Tranquility, Littoral Drift, Wave Transmission, Wave Reflection, Wave Overtopping, Wave Diffraction, Types of Ships, Parts of Ship, Ship Size Parameters, Ship Motions

Overview of Marine structures - Container and bulk terminal, Liquid terminals, Breakwaters, Shipyard facilities, port infrastructures and Bulk Terminals, Walkthrough of Typical Shipyard Cum Port

Operation and components of Ports – Vessel and cargo related Operations of Ports, Berthing Structures – Wharf, Quay, Pier, jetty, Storages - Container yards, Stack yards, Warehouse, Tankage

Site Investigation and Survey – Hydrographic, topographic, Meteorological, Oceanographic, Geological, Seismic, Resources data

Approach Facilities, Navigation Aids – Audible, Radio, Visual, Others, Design considerations and Functional requirements of typical structures, Breakwater Structures, Fenders, Dolphin, Shipyard structures - Slipways, Dry Docks, Floating Docks, and Ship Lifts, Shore protection and Reclamation works

TOTAL: 45 PERIODS

CASE STUDIES

- Case studies of top-down construction with permanent retaining system.
- Case study of an underground station
- Design and orientation of runways
- Design of Drainage and Rainwater harvesting
- Design of parking space

ATTAINMENT OF LEARNING OUTCOMES

STUDENT ASSESSMENT PLAN

A. The conceptualisation and comprehension level of learning outcomes intended through the course is measured through assessments conducted in multiple stages.
B. The understanding of concepts & principles, evolution of practices, codes & guidelines, emerging trends etc. are tested through assessment questions.
C. The skill outcome related to design, computation, workflow, report & work plan preparation, implementation etc. are assessed through assignments. Such assignment questions & answer keys will be shared to the college SPOC for enabling evaluation by respective faculties.

STUDENT ASSESSMENT 1:
Students will have to prepare a basic layout for metro station, considering the various structural elements of metro station and diaphragm wall for the given site specifications.

STUDENT ASSESSMENT 2:
Prepare a basic layout of runway including orientation using Wind Rose diagram and designing runway length.

SOFTWARE EXPOSURE
Learners are exposed to WALLAP (Diaphragm wall analysis software) for 5 % of course duration & STAAD Pro (Analysis software for Metro stations) for 10 % of the course duration.
The students can use free student version of STAAD Pro even post the completion of this course. Diaphragm wall analysis can also be done using the STAAD pro student version.

LEARNING OUTCOMES
Upon completion of this course the learner will be able to:

- LO.1: Create a Conceptual layout of both elevated and underground metro station
- LO.2: Design Diaphragm wall for the construction of Underground Metro station.
- LO.3: Assess the suitability of a given site for the construction of airport, metro and seaport
- LO.4: Comprehend the requirements of airport and the associated service requirements.

SB8003 DESIGN AND CONSTRUCTION OF STEEL BUILDINGS L T P C
1 0 2 2

PRE-REQUISITE

- Analytical skill on determinate & indeterminate structures and design knowledge of steel members
- Exposure to relevant codes and standards (Indian standard codes for Steel, wind and earthquake design)

COURSE LEARNING OBJECTIVES

The course aims to:

- Impart practical aspects of structural steel building design
- Introduce various aspects like selection and planning of structural system and its components, evaluation of actual loads, integration of architectural and services requirements
- Explore the structural modelling, analysis & design, fabrication, execution and inspection of a structural steel building

KEY JOB ROLES

- Design engineer
- Site planning engineer
- Construction engineer
- R&D Engineer
- Design Consultant

OVERVIEW

This course provides the practical aspects in design of a small to medium rise steel building starting from the selection of the appropriate structural system based on building functionality, to the design and detailing of its various components. This course covers the assessment of different loads in the building, application of the same in analysis and design software models, various vertical and lateral load-resisting systems
and the basis of its selection, integration of various services in the building, design and detailing of elements and connections, etc. This course also covers the different stages in design to execution of steel buildings briefly.

UNIT I ANALYSIS & DESIGN PHILOSOPHIES, CODES OF PRACTICE AND GENERAL DESIGN ASPECTS 3T+6P

Structural steel and its Mechanical Properties, Hot Rolled steel sections, Structural Steel sections and section classification.
Analysis and design of buildings as per Codes of Practice, design philosophies, Advantages of steel buildings in comparison with other types of structures
Inputs for the design of a steel building - Design Basis Report covering Site location, Site Specific aspects, building functionality, Construction planning, Geometric parameters of the building, Structural systems, Special geometries and its structural systems, Functional requirements necessary for the end user, Material specifications.
Methods of designing a steel building, Design life of a building, Exposure conditions and corrosion protection, Gravity and lateral load resisting elements and systems, Concrete and reinforcement, Block work, floors and Roofs, Structural steel, bolts, welds, fire proofing and Painting materials

UNIT II COMPUTATION OF VERTICAL, LATERAL & SPECIAL LOADS AND LOAD COMBINATIONS 3T+6P

Calculating the various loads acting on a steel building - Vertical & lateral loads - Effects of each loads separately and in combination – Dead, superimposed dead, live, temperature, MEP service loads - Lateral loads due to wind and seismic effects
Design of wind speed and pressure, Pressure and Force coefficient method, Deflection and drift limits, Drag, interference and dynamic effects Floor Vibration, Fire resistance, Analysis and design methods, Wind load calculation for an example steel building.

UNIT III SELECTION OF LOAD RESISTING SYSTEMS, STRUCTURAL MODELLING, ANALYSIS & DESIGN 3T+6P

Studying the layout plans of the structure – Codes and Reference drawings, Selection of load resisting systems - Load flow in each system -Satisfying stability & strength of the structure - Vertical and lateral load resisting systems, Integration of MEP services and its supporting structures in buildings

Overview of BIM and its importance in structural modelling

Computer aided modelling, analysis & design (STAAD Pro) - Geometric & structural parameters of the structure - Loading the structure - Interpretation of the results of the software – Analysis & design of a multistoried building from a project for comprehending the design from a practical standpoint.

A sample of Structural Design Basis report

UNIT IV DESIGN OF VARIOUS ELEMENTS & CONNECTIONS OF A STEEL BUILDING 3T+6P

Manual & software aided design – Beams, columns, floors, bracings, purlins/girts & facades, base plates & anchor bolts –different conditions of supports, exposure, and purpose of use - Design of connections between the members – Bolted and welded, moment and shear connections to be adopted in various locations of a building

Tension members in buildings – Types and grades of tension members, Design of mullions and transoms

Special connections for equipment and other services like staircases, roof, terrace, and other special elements. Project based on excel spreadsheet development.

UNIT V DESIGN OF AN INDUSTRIAL BUILDING & DETAILING, FABRICATION AND ERECTION ASPECTS 3T+6P

Design of an industrial building - Selection of sections as per requirements - Configuration of the elements and their connectivity - Functional requirements

Beam design Approach for buildings – Manual and software Design of beams- Cantilever beams and built-up beam, torsion in beams and back up beam concept, Service integration in beams, Simplified floor vibration analysis Column Design Approach for buildings -Manual and software design of column, Addressing failures and optimization in column design

Beam-Column design approach for buildings- Design of beam-columns, Base plate and anchor bolts, Planning and design approach of terrace floor, architecturally exposed steel.

Study of General Assembly drawings, Fabrication drawings and procedures - Fabrication processes - Transportation for structural Steel construction and erection - Sequence of erection - Inspection of a completed structure

Good Design, Detailing and construction Practices. Design summary of Example building

TOTAL: 45 PERIODS

CASE STUDIES

A commercial building with multiple storeys with varying load conditions for each storey.

The project work is design of the complete structure given in the case study, from the study of the structural DBR, till the final design output, resulting in a structure satisfying
the architectural & structural requirements.

ATTAINMENT OF LEARNING OUTCOMES

STUDENT ASSESSMENT PLAN

A. The conceptualisation and comprehension level of learning outcomes intended through the course is measured through assessments conducted in multiple stages.

B. The understanding of concepts & principles, evolution of practices, codes & guidelines, emerging trends etc. are tested through assessment questions.

C. The skill outcome related to design, computation, workflow, report & work plan preparation, implementation etc. are assessed through assignments. Such assignment questions & answer keys will be shared to the college SPOC for enabling evaluation by respective faculties.

STUDENT ASSESSMENT 1:
Preparation of a Design Basis Report for a medium rise steel building considering site specific parameters and loading due to functionality, computation of wind speed and pressure, seismic parameters, load combinations, grid planning and structural systems.

STUDENT ASSESSMENT 2:
Analysis and design of a medium rise building containing various structural & non-structural elements, contributing to the loads acting on the building, finally serving the intended functional requirements.

SOFTWARE EXPOSURE
Learners are exposed to STAAD Pro software for 35% of course duration for analysis and design of steel framed building structure including modelling, specifications, loads, and combination of loads.
The students can use free student version of this software post completion of the course.

LEARNING OUTCOMES
On completion of the course, the students will be able to-
Perform the following operations for the given architectural drawing

- LO.1: Design a low to medium industrial steel building using STAAD PRO Software
- LO.2: Examine site specific aspects of the structure like geotechnical investigations, project requirements
- LO.3: Develop Design basis requirements like building functionalities, durability and Materials
- LO.4: Compute loads (Dead, Superimposed, Live, Wind, Seismic) of various elements & services
- LO.5: Understand proper selection and design of vertical & lateral load resisting systems for the various loads acting on the building
- LO.6: Integrate non-structural elements like facades, service supports, etc., to the structure
- LO.7: Create an optimized design of the building, adhering to the codal requirements & functional aspects, using a modeling software.
- LO.8: Interpret structural drawings, fabrication & erection aspects

SB8004 **HIGH RISE BUILDING DESIGN** **L T P C**
1 0 2 2

PRE-REQUISITE

- ➢ Fundamentals of RCC elements design
- ➢ Basic exposure on analysis software
- ➢ Familiarity on IS codes, standards, and handbooks

COURSE LEARNING OBJECTIVES

- The course will present concepts and practical aspects of design & construction of reinforced concrete buildings particularly those about 10 storeys tall and less than 50 meters in height

KEY JOB ROLES

- ➢ Design Engineer
- ➢ Site Planning Engineer
- ➢ Construction Engineer
- ➢ R&D Engineer
- ➢ Design Consultant

OVERVIEW

The course provides key design techniques and practical application aspects from L&T's decades of expertise in designing structures. The course takes the learner through the typical process in designing reinforced concrete buildings particularly those about 10 storeys tall and less than 50 meters in height. This advanced course provides the experience of designing reinforced concrete buildings as it happens in any design office. The course covers schematic design of gravity and lateral load resisting systems in a reinforcedconcrete building, when to choose a particular system and how to size various components (slabs, beams, columns, shear walls). It also includes calculation of loads and analysis of structure, design and detailing of reinforcement in various components in a hands-on manner.

UNIT I INTRODUCTION AND CODES- DESIGN BASIS PARAMETERS AND REPORT 3T+6P

Indian & International Codes for Reinforced concrete Design, Design loads and detailing of reinforcement, Handbooks for reinforced concrete design, National Building Code 2016, Practical building examples, drawing sizes and scales, Reading Drawings – Architectural & Structural.
Introduction to DBR Parameters - Geometric Parameters, Occupancy Categories, Site location and associated parameters, Design life of structures, Material Specifications - Grade of concrete for vertical and floor elements – Grade of reinforcing steel, Exposure and cover requirements, Fire rating requirements, Load Combinations, Serviceability Requirements, Analysis tools, Design Basis Report, Concept explanation with example buildings.

UNIT II LOADS & SETTING THE STRUCTURAL SCHEME 3T+6P

Introduction, dead loads, superimposed dead loads, Live loads, Wind loads, Wind pressure coefficients, Determining global wind forces and wind velocity, storey forces and base shears. Earthquake loads, response spectrum to earthquake excitation, seismic design parameters - horizontal acceleration coefficient, Time period, Evaluation and application of seismic base shear, equivalent static method. Loads due to pressure – earth pressure, hydrostatic pressure. Loads from MEP Services and architectural considerations like façade loads.
Scheme Design, Concrete floor systems, Sizing and design of various slab systems, Dimensioning & designing of drop panels, Beams, Reinforced Concrete Columns - Location and Shape, Design Axial Load, Sizing, Lateral Load Systems, IS 1893- Requirements, Shear Walls – Location and thickness. Estimating relative stiffness of core walls.

UNIT III STRUCTURAL MODELS 3T+6P

Introduction to Analysis & Modelling, Modelling of Cantilever, Portal Frame, three bay Portal Frame, 3D structural models - Geometry, gravity loads, defining earthquake loads, defining wind loads, Modelling Shear walls, Practical Structural Model of building, Structural models of Floor System, Direct design method for Flat Slabs, Analysis of two-way slabs using moment coefficient method,

Application of moment coefficient method, Estimation of deflections
ETABS software demonstration for correct modelling and design of Vertical and Lateral loading systems like Shear Walls

UNIT IV DESIGN OF STRUCTURAL ELEMENTS 3T+6P

Design of structural elements - Design of Beams- flexural reinforcement, shear reinforcement-design of edge beam, Practical examples, Design of flat slabs- Flexural Reinforcement, shear reinforcement- Practical Examples-Design of mesh reinforcement, additional bottom reinforcement, additional top reinforcement, Design of 2-way continuous slabs.
Design of Reinforcements in Columns - Post processing of column forces from analysis, Design and arrangement of vertical reinforcement, Design of horizontal reinforcement, Design of stirrups, Cardinal rules in scheme design of buildings, Coordination with other Engineering disciplines
Design of shear walls – General considerations, Seismic response of RC structures, Vertical and Horizontal Reinforcement, Calculation of design forces, moment capacity of vertical distributed reinforcement,
Design of boundary elements and boundary zone. Sizing of elements based on Constructability aspects like formwork, concrete placement and compaction, rebar arrangement to satisfy economy and optimum utilization.

UNIT V DETAILING OF STRUCTURAL ELEMENTS- BILL OF QUANTITIES AND CONCLUSION 3T+6P

Development length of rebars, detailing of various structural elements - flat slabs, two-way continuous slabs, beams, columns and shear wall, detailing and documentation of practical example building.
Bill of quantities - Concrete and steel indices for RC buildings, Reinforcement consumption in RC members, BoQ of practical example building.

TOTAL: 45 PERIODS

CASE STUDIES

➢ Structural analysis, design and detailing of a multi-storey building with load calculation (dead, live, wind and seismic) as per Indian standard codes using ETABS as analysis t
➢ Bill of Quantities preparation of the multi storey building structure.

ATTAINMENT OF LEARNING OUTCOMES
STUDENT ASSESSMENT PLAN

A. The conceptualisation and comprehension level of learning outcomes intended through the course is measured through assessments conducted in multiple stages.
B. The understanding of concepts & principles, evolution of practices, codes & guidelines, emerging trends etc. are tested through assessment questions.
C. The skill outcome related to design, computation, workflow, report & work plan preparation, implementation etc. are assessed through assignments. Such assignment questions & answer keys will be shared to the college SPOC for enabling evaluation by respective faculties.

STUDENT ASSESSMENT 1:

Preparation of a Design Basis Report for a reinforced concrete building considering site specific parameters and loading due to functionality, computation of wind speed and pressure, seismic parameters, load combinations, grid planning and structural systems.

STUDENT ASSESSMENT 2:

Students will have to model a reinforced concrete building in ETABS by identifying regional seismic and wind load from appropriate code provisions and designing typical structural elements for the critical load combination.

SOFTWARE EXPOSURE

Learners are exposed to ETABS software for 40% of course duration for analysis and design of complete RCC building including modelling, specifications, loads and combination of loads. The students can use free student version of this software post completion of the course.

COURSE OUTCOMES

On completion of the course, the students will be able to-

➢ LO1.: Model a 14-storey building for given location and loading conditions such as wind, seismic and combined loads.

➢ LO2.: Prepare a Design Basis Report for a multi storey building considering site parameters, MEP services and functionality.

➢ LO3.: Compute loads including wind and Seismic and selection of vertical and lateral load resisting systems

SB8005 ROBOTICS SIMULATION FOR MANUFACTURING L T P C
1 0 2 2

COURSE DESCRIPTION:

Robotics is being used in many aspects of manufacturing to help increase productivity and efficiency while lowering production costs. Large number of Robots are deployed in manufacturing industry to collaborate with workers to perform repetitive, monotonous, or intricate tasks under the worker's guidance and control. In this course, students will get exposed to RoboAnalyzer® a 3D model-based software that can be used to teach and learn Robotics concepts. Virtual Robot Module, a part of RoboAnalyzer, has been developed as an application which has joint and Cartesian motion. It has also been made as a COM server, using which one can integrate VRM with MATLAB, MS Excel and other applications that have a COM interface. It also has been integrated with Robotics Toolbox for MATLAB.

COURSE OBJECTIVE:

Students to get aacquaintance with current industry demands, intensive competency needs and scope of the automated Machining in the current industry scenario. Analysis of work holding procedures through simulation software. Programming and setting parameters for desired solutions. Current industry demands, competency needs, job roles and scope of the automated Machining in the current industry and Execute programming solutions using lab exercises integrated into the platform as part of the tutorials.

Unit	**Assessment elements / Coverage**	**Aligned to Course Outcome**
Introduction to Robotics	- Quiz on Introduction to Robotics - Quiz on Anatomy of Robot - Quiz on Robot Configuration - Quiz on DOF, cartesian movement & Drive Systems and End Effectors - Quiz on Sensors in Robotics - Quiz on Industrial Applications of Robots	
Spatial Representation of Object	- Quiz on Relative Position and Orientation of an Object with respect to a reference - Quiz on Homogeneous representation of Position and orientation of an Object - Assignment - Relationship between visual and homogeneous representation of an object using HTM module in RoboAnalyzer - Assignment on Translation - Transformation, rotation transformations and DH Parameter. - LAB - Virtual models of Industrial robots	LO1. Model a 2 DOF planar robotic arm and trace given curved profile through specific intermediant points using cubic polynomial profile.

Robot Kinematics using RoboAnalyzer	- Quiz on Introduction to robot kinematics - Quiz on Forward Kinematics - Quiz on Inverse Kinematics - Quiz on Motion planning of Robots - Quiz on Joint and Cartesian motion - LAB - Assignment on forward and inverse kinematics - LAB - Understanding coordinate frames and transformations - LAB - Inverse and forward Dynamics of robots - LAB - Creating robot joint trajectories - LAB - Assignment on Motion planning in cartesian space - LAB - Case Study: Workspace analysis of a 6 axis Robot	LO2. Do mathematical modelling of the same (as in LO1) robotic arm with different arm length and trace the given profile in the LO1 using RoboAnalyzer**.**

Course Outcomes:

On completion of the course, the students will be able to-
LO1. Model a 2 DOF planar robotic arm and trace given curved profile through specific intermediant points using cubic polynomial profile.
LO2. Do mathematical modelling of the same (as in LO1) robotic arm with different arm length and trace the given profile in the LO1 using RoboAnalyzer.

Prerequisites:

- Engineering Mathematics,
- Kinematics and Mechanics

Student Assessment Plan:

The whole Assessment framework is built around our proprietary 'Measure & Reward' framework. Each part of the Assessment is Objective oriented and measurable. Additionally, it enables staged scoring on final simulation attributes, such that student is rewarded for
stagewise progression as well overall attainment.

Internals + Theory assessment– 40 Marks

- Unit Testes – LMS Based (Online, MCQ)
- Every Sub-units /Unit will have a Quiz / overall Graded Quiz other than Lab exercise and Capstone Projects
- All Assessments are online based and self-graded
- Average of Unit wise Assessments

Final Practical Assessment – 60 Marks

- Experiment parameters and Questions are provided for Students
- Students have to Study the experiment and simulate it in the software and submit the Environment/Simulation Robot programming file through LMS
- Based on the simulation and the Result of the simulation assessment will be Qualified

Student Assessment Plan for term 1:

Students will be given various profiles similar to the profile given below and ask to program in RoboAnalyzer for tracing the given profile. Students will be asked to restrict the arm length to 0.7 m and 0.4 m. Students will be considered as qualified for term 1 for exactly tracing the given profile

Student Assessment Plan for term 2:

Students will be given a different arm length of both the arms with variation upto 20% from their term 1 assessment and ask to do a mathematical modeling for the new arm length and do the simulation for tracing the profile given in the term 1.

NOS alignment

Aligned with NSDC – SSC NOS Standards.

Sr. #	QP No.	NSQF	Qualification	NOS No.	Detail
1	ASC/Q8304	Level 6	Automotive Robotics and Automation	ASC/N8315	Simulation and integration of robot and automation system

SB8006 ELECTRIC SYSTEMS FOR E-MOBILITY (MECHANICAL) **L T P C**
1 0 2 2

COURSE DESCRIPTION:

The global market for electric vehicles (EVs) is growing continuously at a compounded annualized growth rate (CAGR) of 21.7 per cent. It is expected to grow from 8.1 million units to 39.21 million units by 2030. This exponential growth is being driven by various factors, including concerns for pollution.
In this course, students will get exposed to Electric vehicle & mobility and automation. Understand and demonstrate converter circuits. Build firm foundation in lithium-ion cell terminology and function and in battery-management-system. Get exposed and implement motors and motor control units. Learn & demonstrate the purpose of each component in an equivalent-circuit model of a lithium-ion battery cell, how to determine their parameter values from lab-test data, and how to use them to simulate cell behaviors under different load profiles.

COURSE OBJECTIVE:

Students to get exposed to Electric vehicle & mobility dynamics & Battery Management Systems. Understand and build strong foundation on advanced concepts of switched-mode converter circuits. Learn about motors and its control units & Implement the motor and accompanying rotary sensor into a motor control circuit in both hardware and software. Demonstrate equivalent circuit cell model simulation.

UNIT I INTRODUCTION TO ELECTRIC VEHICLES & AUTOMATION (3T+ 6P)

THEORY COMPONENT:

- Future of Mobility – [5 Videos, 3 Readings,2 Quizzes]
- Electrification : The Basic Technologies (Part 1) Electric Vehicles, batteries, EVs Made up of– [5 Videos, 2 Reading,2 Quizzes]
- Electrification : The Basic Technologies (Part 2) –Charging & Charging Infrastructure, EV & the power systems, Industry Perspective on Applications of Electrification [7 Videos, 6 Readings, 2 Quizzes]
- Electrification Impacts – [7 Videos, 2 Quizzes]
- Vehicle Automation – The Basic Technologies – [9 Videos, 1 Reading, 2 Quizzes]
- Automation – The Impacts – [6 Videos,1 Quiz]

PRACTICAL/LAB COMPONENT: NA

UNIT II CONVERTER CIRCUITS (3T+ 6P)

THEORY COMPONENT:

- Single-, Two, and Four-Quadrant Switches - [3 Videos,1 Readings ,2 Assignment]
- Basic issues of Power Semiconductors- [11 Videos,1 Readings & 2 Assignment]
- Introduction to DCM and Mode Boundary - [3 Videos, 1 Readings ,2 Assignment]
- Converter Topologies - [6 Videos, 1 Readings,1 Assignment]

PRACTICAL/ASSIGNMENT COMPONENT:

1. Understand why a diode works in some cases, while a transistor is needed in others
2. Understand when single-quadrant, two-quadrant, or four-quadrant switch realizations are needed
3. Complete Assignment to Understand the tradeoff between voltage breakdown, switching time, and forward voltage drop in a power semiconductor device
4. Complete Assignment to Model switching loss using equivalent circuits
5. Complete Assignment to Design gate drivers
6. Work on LTspice File: Synchronous Boost Converter, with associated driver, dead time generator, and PWM models
7. Work on assignment origin of discontinuous conduction modes
8. Will be able to Analyze a converter to find the CCM-DCM mode boundary
9. Will be able to Analyze a converter circuit to find its conversion ratio in DCM
10. Switching Loss Modeling and DCM Analysis
11. Conversion ration analysis of the Cuk Converter in DCM
12. Get exposed to solved study problems on DCM analysis
13. Understand the origins of basic converter topologies
14. Student will be able to Analyze converter circuits containing transformers
15. Apply transformer analysis techniques to the forward converter
16. Apply transformer analysis techniques to the flyback converter

UNIT III MOTOR AND MOTOR CONTROL CIRCUITS (3T+ 6P)

THEORY COMPONENT:

- AC motor Designs - [8 Videos, 2 Readings, 1 Quiz & 1 Assignment]
- AC motor Control – [7 Videos ,1 Reading & 1Quiz & 1 Assignment]
- DC motors – [8 Videos , 1 Readings & 1 Quiz & 1 Assignment]
- DC motor control and stepper motors - [5 Videos, 1 Readings,1 Quiz, 2 Lab]

PRACTICAL/LAB COMPONENT:

1. Motor Voltage and Current Measurement Lab Assignment

Course Project Quiz 1 - Build a DC Motor circuit, and use it to understand about motor Measurements

Course Project 2 Quiz - Build a rotary switch circuit, and use it to understand about switch timing

UNIT IV INTRODUCTION TO BATTERY MANAGEMENT SYSTEM (3T+ 6P)

THEORY COMPONENT:

- Battery Boot Camp - [8 Videos,13 Readings ,7 Quizzes]
- How lithium-ion cells works - [7 Videos,7 Readings & 7 Quizzes]
- BMS sensing and high-voltage control - [9 Videos, 9 Readings ,8 Quizzes]
- BMS design requirements 2-5 - [8 Videos, 8 Readings,8 Quizzes]
- How are cells made? How can they fail?- [5 Videos, 5 Readings,4 Quizzes]

PRACTICAL/LAB COMPONENT: NA

UNIT V : EQUIVALENT CIRCUIT CELL MODEL SIMULATION (3T+ 6P)

THEORY COMPONENT:

- Defining an equivalent-circuit model of a Li-ion cell - [9 Videos, 14 Readings, 9 Quizzes & 1 Overall Quizz]
- Identifying parameters of static model - [6 Videos, 7 Readings, 6 Quizzes & 1 Overall Quiz]
- Identifying parameters of dynamic model- [9 Videos, 9 Readings, 7 Quizzes & 1 Overall Quiz]
- Simulating battery packs in different configurations - [6 Videos, 6 Readings, 6 Quizzes & 1 Overall Quiz]
- Co-simulating battery and electric-vehicle load - [7 Videos, 7 Readings, 5 Quizzes & 1 Overall Quiz]

PRACTICAL/LAB COMPONENT:

1. Octave Code to determine static part of ECM – Jupyter notebook used in conjunction (20 Mins)
2. Identifying parameters of static model - Jupyter notebook used in conjunction (1 Hour)
3. Octave Code to determine dynamic part of an ECM (20 Mins)
4. Octave Code to simulate an ECM (20 Mins)
5. Octave code to look up model parameter value (20 Mins)
6. Octave code to compute OCV (20 Mins)
7. ECM to simulate constant voltage (30 Mins)
8. ECM to simulate constant power (30 Mins)
9. Octave code to simulate PCM's (30 Mins)
10. Octave code to simulate SCM's (30 Mins)
11. Octave code to co-simulate EV and Battery (1 Hour)
12. Tune a Thevenin model using Octave code to match laboratory data set (1 Hour)
13. Tune an Rint model using Octave code to match laboratory data set (1 Hour)
14. Manually tuning an ESC cell model – (10 Mins)

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Students will be able to,

- Get exposed to the concepts & need of Electric vehicles , Mobility & Automation
- How to implement the power semiconductor devices in a switching converter
- Understand the origins of the discontinuous conduction mode and be able to solve converters operating in DCM
- Demonstrate the basic dc-dc converter and dc-ac inverter circuits
- How to implement transformer isolation in a dc-dc converter, including the popular forward and flyback converter topologies

- How to specify the proper AC or DC motor for a machine design
- Integrate the motor to a machine, based on analysis of motor equations for voltage, current, torque and speed.
- Implement the motor and accompanying rotary sensor into a motor control circuit in both hardware and software.
- Add a motor and motor control circuit into a microprocessor based development kit.
- Create hardware and firmware to process motor feedback data to a microprocessor for further evaluation.

- List the major functions provided by a battery-management system and state their purpose
- Match battery terminology to a list of definitions - Identify the major components of a lithium-ion cell and their purpose
- Understand how a battery-management system "measures" current, temperature, and

isolation, and how it controls contactors
- Identify electronic components that can provide protection and specify a minimum set of protections needed
- Compute stored energy in a battery pack
- List the manufacturing steps of different types of lithium-ion cells and possible failure modes
- State the purpose for each component in an equivalent-circuit model
- Compute approximate parameter values for a circuit model using data from a simple Lab test
- Determine coulombic efficiency of a cell from lab-test data
- Use provided Octave/MATLAB script to compute open-circuit-voltage relationship for a cell from lab-test data
- Use provided Octave/MATLAB script to compute optimized values for dynamic parameters in model
- Simulate an electric vehicle to yield estimates of range and to specify drivetrain Components
- Simulate battery packs to understand and predict behaviours when there is cell-to-cell variation in parameter values

Mandatory Project work

1. Motor Voltage and Current Measurement Lab
   Course Project - Build a DC Motor circuit, and use it to understand about motor Measurements
   Course Project - Build a rotary switch circuit, and use it to understand about switch timing

2. Student to modify three sample Octave programs to create functions that can simulate temperature-dependent cells, battery packs built from PCMs, and battery packs built from SCMs

Test Project: -

Design of battery pack for 48V 1000W electric vehicle and determine coulomb efficiency and equivalent circuit parameters using Octave/MATLAB

List of Software Students are exposed to

- Jupyter Notebook

Duration of availability of Licensed Software to Students

- For the entire Semester (Could be extended if required for specific candidates)

List of consumables that will be given to per student

- License for accessing respective Courses
- Orientation on portal access
- Doubt clarification session based on need basis
- Automatic Graded Assessment reports
- Access to discussion forums to relevant courses/steams

Student Assessment Plan

- Every Sub-units will have a Quiz and every Unit will have an overall Graded Quiz other than Lab exercise and Capstone Projects
- Few Assignments are also provided for practice in addition to Quiz and Graded assessments
- All Assessments are online based and self-graded
- If a students does not score the required minimum of 80% , he will be asked to retake the tutorial and attempt the Quiz again.

Unit 1 – Introduction to Electric Vehicles & Automation

- Quiz on Mobility Terms
- Quiz on Mobility – Past, Present & Future
- Quiz on EVs Made of?
- Quiz on Battery Technology
- Quiz on Stakeholders of Electrification

Overall Graded assessment on all the above topics

- Quiz on Sustainability & Equity
- Quiz on Impacts of Electrification
- Quiz on Autonomous Vehicles Components
- Quiz on Impacts of Automation

Unit 2 – Converter Circuits

- Assignment on why a diode works in some cases, while a transistor is needed in others
- Assignment on when single-quadrant, two-quadrant, or four-quadrant switch realizations are needed
- Homework Assignment on Switch Realisation
- Assignment on Simulation to trade off between voltage breakdown, switching time, and forward voltage drop in a power semiconductor device, Model switching loss using equivalent circuits & Design gate drivers
- Homework Assignment on the origin of discontinuous conduction modes
- Analyze a converter to find the CCM-DCM mode boundary
- Analyze a converter circuit to find its conversion ratio in DCM
- Demonstrate the origins of basic converter topologies
- Analyze converter circuits containing transformers
- Apply transformer analysis techniques to the forward converter
- Apply transformer analysis techniques to the flyback converter

Unit 3 – Motor & Motor Control Circuits

- Quiz on AC Motor Designs
- Quiz on AC Motor Control
- Quiz on DC Motors
- Quiz on DC Motors Control and Stepper Motors

- Motor Voltage and Current Measurement Lab Assignment

  Course Project Quiz 1 - Build a DC Motor circuit, and use it to understand about motor Measurements

  Course Project 2 Quiz - Build a rotary switch circuit, and use it to understand about switch timing

Unit 4 – Introduction to Battery Management System

- Pre-requisite Quiz on Battery Boot Camp
- Quiz on battery terminology
- Quiz on parts of electrochemical cell
- Quiz on electro chemical cell storage and release energy
- Quiz on materials to use in electrochemical cell

Overall assessment on all the above topics

- Quiz on lithium-ion cells
- Quiz on lithium-ion cells different from electrochemical cells
- Quiz on negative electrodes for lithium-ion cells
- Quiz on positive electrodes for lithium-ion cells
- Quiz on electrolytes and separators for lithium-ion cells
- Quiz on lithium to run out

Overall assessment on all the above topics

- Quiz on primary functions of a BMS
- Quiz on Modular design
- Quiz on Cell Voltage in a BMS
- Quiz on sense module temperature in a BMS
- Quiz on sense battery-pack current in a BMS
- Quiz on control contactors with a BMS
- Quiz on electrical isolation in a BMS

Overall assessment on all the above topics

- Quiz on BMS Protect the user and battery pack
- Quiz on BMS interface with other system components
- Quiz on BMS estimate SOC and SOH
- Quiz on Cell SOC and Battery-pack SOC
- Quiz on computing cell available energy and power
- Quiz on computing battery pack available energy and power
- Quiz on kinds of diagnostics must for a BMS report

Overall assessment on all the above topics

- Quiz on lithium-ion cell's electrodes fabricated
- Quiz on lithium-ion cell assembled
- Quiz on lithium-ion cell aging processes
- Quiz on abnormal cell aging processes and failure modes

Unit 5 - Equivalent Circuit Cell Model Simulation

- Quiz on Ope-circuit voltage (OCV) and State-of-charge (SOC)
- Quiz on How do we model voltage
- Quiz on Warburg impedance & its implementations
- Quiz on Convert a continuous-time model to discrete-time model
- Quiz on Model parameter values
- Quiz on Hysteresis in a lithium-ion cell and its modelling
- Quiz on equivalent-circuit model of a lithium-ion cell

Overall assessment on all the above topics

- Quiz on cell Characterization
- Quiz on open-circuit voltage determination
- Quiz on Cell's coulombic efficiency and total capacity
- Quiz on Cell's temperature dependent OCV
- **LAB** – Jupyter notebook - To be used in Conjunction with Octave code to determine static part of ECM

-Quiz on Octave code to determine static part of ECM
-**LAB** – Jupyter notebook - To be used in Conjunction with identifying parameters of static model and next steps

-Quiz on Determining dynamic-model parameters
-Quiz on cell data used to find dynamic-model parameter values
-**LAB** – Jupyter notebook to run for octave code to determine dynamic part of an ECM
-Quiz on octave code to determine dynamic part of an ECM
-**LAB** – Jupyter notebook to run for octave code to simulate an ECM
-Quiz on octave code to simulate an ECM
-**LAB** – Jupyter notebook to run for octave code to look up model parameter value
-Quiz on octave code to look up model parameter value
-**LAB** – Jupyter notebook to run for octave code to compute OCV
-Quiz on octave code to compute OCV

Overall assessment on all the above topics

-**LAB** – Jupyter notebook to run for ECM to simulate constant voltage

-Quiz on how to use ECM to simulate constant voltage
-**LAB** – Jupyter notebook to run for ECM to simulate constant power
-Quiz on how to use ECM to simulate constant power
-Quiz on Simulate battery packs
-**LAB** – Jupyter notebook to run for Octave code to simulate PCM's
-Quiz on Octave code to simulate PCM's
-**LAB** – Jupyter notebook to run for Octave code to simulate SCM's
-Quiz on Octave code to simulate SCM's

Overall assessment on all the above topics

- Quiz on develop a load/battery co-simulator
- Assignment on how to Infer the information needed to develop a load/battery co-simulator based on the example taught.
- Assignment on how to Analyze vehicle/battery co-simulation block diagram to understand the dependencies of simulation variables.

- Quiz on Modelling ideal vehicle dynamins
  Quiz on practical limits to model of vehicle dynamics
  Quiz on calculating electric-vehicle range

  -**LAB** – Jupyter notebook to run for Octave code to set up EV simulation
  -**LAB** – Jupyter notebook to run for Octave code to conduct EV simulation
  -Quiz on Octave code to set up EV simulation and conduct EV simulation
  - **LAB – Capstone Project to** modify three sample Octave programs to create functions that can simulate temperature-dependent cells, battery packs built from PCMs, and battery packs built from SCMs.
  - Assignment – Programming Assignment for manually tuning an ESC cell model

Documentary Evidence –

1. https://www.coursera.org/learn/people-technology-and-the-future-of-mobility
2. https://www.coursera.org/learn/converter-circuits
3. https://www.coursera.org/learn/motors-circuits-design
4. https://www.coursera.org/learn/battery-management-systems
5. https://www.coursera.org/learn/equivalent-circuit-cell-model-simulation

SB8007 MACHINE LEARNING WITH APPLICATION TO OBJECT RECOGNITION **L T P C 1 0 2 2**

COURSE OBJECTIVE

The objective of this course is to provide a view of data science, recognize why data science is gaining importance in today's business world to comprehend where data science can be applied across industry domains to understand major components of data science stack to learn how a data science project is implemented step-by-step in each business use-case

Pre-requisite courses:

Pre-requisite Knowledge	Courses Available on Springboard
Probability and Statistics	Probability and Statistics Probabilty distribution using Python Statistical Interence using Python
Python Programming Language	Programming Fundamentals using Python - Part 1
Linear Algebra	Basics of Linear Algebra
Regression Analysis	Regression Analysis
Deep Learning	Deep Learning for Developers
Exploratory Data Analysis	Exploratory data analysis

UNIT I INTRODUCTION TO AI AND DATA SCIENCE 7

Why AI? - What is AI? - AI in Practice - AI in Business - AI Platforms. Data Science: The Data Revolution - Components of Data Science - Data Science in Action – Conclusion.

UNIT II PYTHON FOR DATA SCIENCE 14

Why Python Libraries – NumPy - Introduction to NumPy - Operations on NumPy – Pandas – Introduction to Pandas – Introduction to Pandas Object – Working with datasets – Pandas Plots - Matplotlib – Introduction to Matplotlib – Types of Plots – Scikit-learn – Machine Learning using sklearn. [Practical hands-on exercises using NumPy, Pandas, Matplotlib]

UNIT III DATA VISUALIZATION USING PYTHON 6

Data visualization using Python: Data Visualization: Developing insights from data using Basic Plots using Matplotlib (Box, Scatter, Line, Bar, Pie, Histogram), Statistical analysis using Heatmap, Kernel Density plot using Seaborn, Network Graphs, Choropleth Map Using Ploty, Word Cloud. [Practical hands-on exercises for creating charts]

UNIT IV EXPLORE MACHINE LEARNING USING PYTHON 15

Introduction to Machine Learning - Regression – Classification – Clustering – Introduction to Artificial Neural Network. [Hands-on Exercises for Practicing Machine Learning Models Using Capstone Project]

UNIT V OBJECT DETECTION AND RECOGNITION USING DEEP LEARNING IN OPENCV 3

Basic Operations and Algorithms in OpenCV - Object Detection and Recognition Using Features - Deep Learning in OpenCV - Object Classification Using Deep Learning
Recognizing Text in an Image.

TOTAL : 45 PERIODS

SUGGESTED ACTIVITIES

- Continuous / Self-Assessment (MCQ)
- Capstone Project - Build a ML model using a sample image dataset, to detect or identify specific features in sample image such as mask on human face etc.,

SUGGESTED EVALUATION METHODS

- Video Proctored Exam
- Self-Assessment

COURSE OUTCOMES

On completion of the course, students will be able to:

CO1 : Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations.

CO2 : Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.

CO3 : Assess and select appropriate data analysis models for solving real-world problem.

CO4 : Demonstrate the importance of data visualization, design, and use of visual components.

CO5 : Demonstrate fundamental understanding of applications of machine learning for object recognition

REFERENCE(Course Material)

1. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_8840337130015322000_shared/overview (Introduction to AI)
2. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_12666306402263577000_shared/overview (Introduction to Data Science)
3. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01333063698060902494_shared/overview (Python for Data Science)
4. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_0126051913436938241455_shared/overview (Data visualization using Python)
5. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_012600400790749184237_shared/overview (Explore Machine Learning)
6. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_0130944396404162562520_shared/overview (Object Detection and Recognition Using Deep Learning in OpenCV)

Mode of Training	Online (Self-Learning)
Course Evaluation	Online Assessment
Multiple Hybrid Branch of Students	Applicable for IT/CSE
Internship/Placement Opportunities	https://infytq.onwingspan.com/
NOS Alignment	Yes, Infosys Industry Standard
Train-the-Trainer	Faculty Enablement Program
Commercials	Free of Cost

SB8008	MACHINE LEARNING	L	T	P	C
		1	0	2	2

COURSE OBJECTIVE

The objective of this course is to provide a view of data science, machine learning, basic implementation using Python and how machine learning is applied in various domains in the industry

Pre-requisite courses:

Pre-requisite Knowledge	Courses Available on Springboard
Probability and Statistics	Probability and Statistics Probabilty distribution using Python Statistical Interence using Python
Python Programming Language	Programming Fundamentals using Python - Part 1
Linear Algebra	Basics of Linear Algebra
Regression Analysis	Regression Analysis

UNIT I INTRODUCTION TO ARTIFICIAL INTELLIGENCE 6

Why AI? - What is AI? - AI in Practice - AI in Business - AI Platforms.

UNIT II INTRODUCTION TO DATA SCIENCE 4

Data Science: The Data Revolution - Components of Data Science - Data Science in Action – Conclusion.

UNIT III PYTHON FOR DATA SCIENCE 14

Why Python Libraries – NumPy - Introduction to NumPy - Operations on NumPy – Pandas – Introduction to Pandas – Introduction to Pandas Object – Working with datasets – Pandas Plots - Matplotlib – Introduction to Matplotlib – Types of Plots – Scikit-learn – Machine Learning using sklearn. [Practical hands-on exercises using NumPy, Pandas, Matplotlib]

UNIT IV DATA VISUALIZATION USING PYTHON 6

Data visualization using Python: Data Visualization: Developing insights from data using Basic Plots using Matplotlib (Box, Scatter, Line, Bar, Pie, Histogram), Statistical analysis using Heatmap, Kernel Density plot using Seaborn, Network Graphs, Choropleth Map Using Ploty, Word Cloud. [Practical hands-on exercises for creating charts]

UNIT V EXPLORE MACHINE LEARNING USING PYTHON 15

Introduction to Machine Learning - Regression – Classification – Clustering – Introduction to Artificial Neural Network. [Hands-on Exercises for Practicing Machine Learning Models Using Capstone Project]

TOTAL: 45 PERIODS

SUGGESTED ACTIVITIES

- Continuous / Self-Assessment (MCQ)
- Capstone Project – Build a ML model using a given numerical COVID'19 dataset, predict the number of confirmed cases for next ten days in different areas of the world

SUGGESTED EVALUATION METHODS

- Video Proctored Exam
- Self-Assessment

COURSE OUTCOMES

On completion of the course, students will be able to:

CO1 : Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations.

CO2 : Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.

CO3 : Assess and select appropriate data analysis models for solving real-world problem.

CO4 : Demonstrate the importance of data visualization, design, and use of visual components.

REFERENCE

1. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_8840337130015322000_shared/overview (Introduction to AI)
2. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_12666306402263577000_shared/overview (Introduction to Data Science)
3. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_0133306369806090249 4_shared/overview (Python for Data Science)
4. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_0126051913436938241 455_shared/overview (Data visualization using Python)
5. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_0126004007907491842 37_shared/overview (Explore Machine Learning Using Python)

Mode of Delivery	Online (Self-Learning)
Software Configuration to be arranged in Institution Premises	○ Python and related libraries
Hardware Configuration to be arranged in Instituion Premises	○ Windows 10, 16GB RAM
Course Evaluation	Online Assessment
Multiple Hybrid Branch of Students	Applicable for Mechanical/Chemical
Internship/Placement Opportunities	https://infytq.onwingspan.com/
NOS Alignment	Yes- Infosys Industry Standard
Train-the-Trainer	Faculty Enablement Program
Commercials	Free of Cost

SB8009 ELECTRIC VEHICLE CHARGING SYSTEMS FOR EEE LT P C
1 0 2 2

COURSE DESCRIPTION:

The global market for electric vehicles (EVs) is growing continuously at a compounded annualized growth rate (CAGR) of 21.7 per cent. It is expected to grow from 8.1 million units to 39.21 million units by 2030. This exponential growth is being driven by various factors, including concerns for pollution.

In this course, students will get exposed to Electric vehicle, Predict aspects of mobility in the future. Comprehend the basics of battery technology. covers developing equivalent circuit model for the battery pack for performing various studies like OCV and ECM in simulation aspect. It also covers fault estimation in battery packs during short circuit and overload. The control system should kick in to protect the battery pack with design constrains.

COURSE OBJECTIVE:

Students to get exposed to Electric vehicle & mobility dynamics & Battery Management Systems. Demonstrate Battery State-of-charge (Estimation) & Battery State-of –Health (SOH) Estimation using lab exercises integrated in the platform as part of the tutorials. Design of various converter topologies which involves selection of components, switching pulses and switches using LTspice simulation tool, sensing of various battery parameters like SCO and SOH and developing EKF and SPKF using Octave Code.

To Design 48v 36Ah LIFEPO4 battery pack for the dimension of 430mm(L) x 15mm(B) x 160mm(H) and develop the control circuit for sensing the individual array temperature with OV and UV protection with minimum harmonic content also calculate the SOC and SOH using Octave model

COURSE CURRICULUM

UNIT I INTRODUCTION TO ELECTRIC VEHICLES & AUTOMATION 3T+6P

Theory component:
- Future of Mobility – *[5 Videos, 3 Readings,2 Quizzes]*
- Electrification : The Basic Technologies (Part 1) Electric Vehicles, batteries, EVs Made up of– *[5 Videos, 2 Reading,2 Quizzes]*
- Electrification : The Basic Technologies (Part 2) –Charging & Charging Infrastructure, EV & the power systems, Industry Perspective on Applications of Electrification *[7 Videos, 6 Readings, 2 Quizzes]*
- Electrification Impacts – *[7 Videos, 2 Quizzes]*
- Vehicle Automation – The Basic Technologies – *[9 Videos, 1 Reading, 2 Quizzes]*
- Automation – The Impacts – *[6 Videos,1 Quiz]*

UNIT II EQUIVALENT CIRCUIT CELL MODEL SIMULATION 3T+6P

Theory component:

- Defining an equivalent-circuit model of a Li-ion cell - *[9 Videos, 14 Readings, 9 Quizzes & 1 Overall Quiz]*
- Identifying parameters of static model - *[6 Videos, 7 Readings, 6 Quizzes & 1 Overall Quiz]*
- Identifying parameters of dynamic model- *[9 Videos, 9 Readings, 7 Quizzes & 1 Overall Quiz]*
- Simulating battery packs in different configurations - *[6 Videos, 6 Readings, 6 Quizzes & 1 Overall Quiz]*
- Co-simulating battery and electric-vehicle load - *[7 Videos, 7 Readings, 5 Quizzes & 1 Overall Quiz]*

Practical/Lab component:

1. Octave Code to determine static part of ECM – Jupyter notebook used in conjunction
2. Identifying parameters of static model - Jupyter notebook used in conjunction
3. Octave Code to determine dynamic part of an ECM
4. Octave Code to simulate an ECM
5. Octave code to look up model parameter value
6. Octave code to compute OCV
7. ECM to simulate constant voltage
8. ECM to simulate constant power
9. Octave code to simulate PCM's
10. Octave code to simulate SCM's
11. Octave code to co-simulate EV and Battery
12. Tune a Thevenin model using Octave code to match laboratory data set
13. Tune an Rint model using Octave code to match laboratory data set
14. Manually tuning an ESC cell model

UNIT III INTRODUCTION TO BATTERY MANAGEMENT SYSTEM 3T+6P

Theory component:

- Battery Boot Camp - *[8 Videos,13 Readings ,7 4 Quizzes/Assessment]*
- How lithium-ion cells work - *[7 Videos,7 Readings & 7 Quizzes/Assessment]*
- BMS sensing and high-voltage control - *[9 Videos, 9 Readings ,8 Quizzes/Assessment]*
- BMS design requirements 2-5 - *[8 Videos, 8 Readings,8 Quizzes/Assessment]*

(Exclude Week 5 Content in the course)

Practical/Lab component: NA

UNIT IV AC MOTOR CONTROL COMPONENTS, MOSFET & BATTERY SOC ESTIMATION 3T+6P

Theory component:

- AC Motor Control Components - *[1 Video] – WEEK 2: 5TH TOPIC*
- Power Semiconductor Switches (Ch.4.2) Power MOSFETs, MOSFET Gate Drivers, BJTs and IGBTs , More About Switching Loss, Wide Bandgap Power Semiconductors *– [1 Videos]*
- What is the importance of a good SOC estimator - *[8 Videos, 4 Readings, 7 Quizzes]*
- Linear Kalman filter as a state estimator - *[6 Videos, 6 Readings, 6 Quizzes]*
- Linear Kalman filter - *[7 Videos, 7 Readings, 7 Quizzes]*
- Cell SOC estimation using an extended Kalman filter - *[8 Videos, 8 Readings, 7 Quizzes]*
- Cell SOC estimation using a sigma-point kalman filter - *[7 Videos, 7 Readings, 6 Quizzes]*
- Improving computational efficiency using the bar-delta method - *[5 Videos, 5 Readings, 4 Quizzes]*

Practical/Lab component:

1. Voltage based SOC estimation - LAB Exercise & Software Used for Practical Exercise This Jupyter notebook implements voltage-based methods for SOC estimation. This notebook implements two voltage-based SOC-estimation methods. The first one simply looks up cell terminal voltage under load in an OCV from SOC table. The second attempts to compensate for the effects of cell equivalent-series resistance
2. Generating correlated random vector
3. Sample code implementing linear Kalman filter
4. Simple EKF with octave code
5. Preparing to implement EKF on an ECM
6. Octave implementation of EKF to estimate SOC
7. Simple SPKF with Octave code

8. Octave implementation of SPKF to estimate SOC
9. Octave implementation of a bar-delta filter

Capstone project

- Execute Capstone Project - Tuning an EKF for SOC Estimation
- Execute Capstone Project - Tuning an SPKF for SOC Estimation

UNIT V BATTERY STATE-OF –HEALTH (SOH) ESTIMATION & MITIGATION OF HARMONICS 3T+6P

Theory component:

- How does lithium-ion cell health degrade? - *[8 Videos, 3 Readings, 3 Quizzes]*
- Total-least-squares battery-cell capacity estimates - *[7 Videos, 7 Readings, 7 Quizzes]*
- How to write code for the different total-capacity estimators - *[6 Videos, 6 Readings, 6 Quizzes]*
- Introduction to Modeling and Control of Single-Phase Rectifiers and Inverters, Introduction to Grid-Tied Power Electronics, Low Hormonic Rectifiers, CCM and DCM Operation of the Boost Low-Harmonic Rectifier - *[8 Videos,3 Readings,3 Quizzes]*
- Control of the PFC Boost Rectifier, Input Voltage Feedforward Compensation, Loss-Free Resistor Model - *[10 Videos,5 Practice Exercises]*

Practical/Lab component:

1 Demonstrate estimate cell series resistance
2 Will be able to execute on finding the ordinary least squares solution as a benchmark
3 Execute ordinary-least-squares solution computationally efficient
4 Able to Find the solution to a weighted total-least-squares problem
5 Confidence intervals on least-squares solutions
6 Implement Simplifying the total-least-squares solution for cases having proportional uncertainties
7 Demonstrate Making simplifies solution computationally efficient
8 Finding solution to the AWTLS Problem
9 Write Octave code to estimate cell total capacity
10 Demonstrating Octave code HEV: Scenario 1
11 Demonstrating Octave code HEV: Scenario 2-3
12 Demonstrating Octave code BEV: Scenario 1
13 Demonstrating Octave code BEV: Scenario 2-3
14 Execute Robustness and Speed
15 Will be able to execute A Kalman filter approach to total capacity estimation
16 Access Matlab ; Demonstrate understanding of power factor and harmonics in the context of grid-tied power electronics. Assignment on Universal-Input Boost Low-Harmonic Rectifier
17 Assignment Quiz on DCM Flyback as PFC Rectifier, Demonstrate understanding of operating principles of low-harmonic, power factor correction rectifiers ; Demonstrate ability to model single phase low harmonic rectifiers

Execute the Capstone Project - Tuning xLS algorithms for total capacity estimation & explore a different way to determine the "x" and "y" data you use as input to the total-capacity estimation methods.

TOTAL : 45 PERIODS

Mandatory Project work

- Execute Capstone Project - Tuning an EKF for SOC Estimation
  Execute Capstone Project - Tuning an SPKF for SOC Estimation
- Execute the Capstone Project - Tuning xLS algorithms for total capacity estimation & explore a different way to determine the "x" and "y" data you use as input to the total-capacity estimation methods.

Test Project :-

Design 48v 36Ah LIFEPO4 battery pack for the dimension of 430mm(L) x 15mm(B) x 160mm(H) and develop the control circuit for sensing the individual array temperature with OV and UV protection with minimum harmonic content also calculate the SOC and SOH using Octave model

Student Assessment Plan

- *Every Sub-units will have a Quiz and every Unit will have an overall Graded Quiz other than Lab exercise and Capstone Projects*
- *All Assessments are online based and self-graded*
- *If a students does not score the required minimum of 80% , he will be asked to retake the tutorial and attempt the Quiz again.*

Unit 1 – Introduction to Electric Vehicles & Automation

- Quiz on Mobility Terms
- Quiz on Mobility – Past, Present & Future
- Quiz on EVs Made of?
- Quiz on Battery Technology
- Quiz on Stakeholders of Electrification

Overall Graded assessment on all the above topics

- Quiz on Sustainability & Equity
- Quiz on Impacts of Electrification
- Quiz on Autonomous Vehicles Components
- Quiz on Impacts of Automation

Unit 2 : – Equivalent Circuit Cell Model Simulation

- Quiz on Open-circuit voltage (OCV) and State-of-charge (SOC)
- Quiz on How do we model voltage
- Quiz on Warburg impedance & its implementations
- Quiz on Convert a continuous-time model to discrete-time model
- Quiz on Model parameter values
- Quiz on Hysteresis in a lithium-ion cell and its modelling
- Quiz on equivalent-circuit model of a lithium-ion cell

Overall assessment on all the above topics

- Quiz on cell Characterization
- Quiz on open-circuit voltage determination
- Quiz on Cell's coulombic efficiency and total capacity
- Quiz on Cell's temperature dependent OCV
- **LAB** – Jupyter notebook - To be used in Conjunction with Octave code to determine static part of ECM
- Quiz on Octave code to determine static part of ECM
- **LAB** – Jupyter notebook - To be used in Conjunction with identifying parameters of static model and next steps
- Quiz on Determining dynamic-model parameters
- Quiz on cell data used to find dynamic-model parameter values
- **LAB** – Jupyter notebook to run for octave code to determine dynamic part of an ECM
- Quiz on octave code to determine dynamic part of an ECM
- **LAB** – Jupyter notebook to run for octave code to simulate an ECM
- Quiz on octave code to simulate an ECM
- **LAB** – Jupyter notebook to run for octave code to look up model parameter value
- Quiz on octave code to look up model parameter value
- **LAB** – Jupyter notebook to run for octave code to compute OCV

-Quiz on octave code to compute OCV

Overall assessment on all the above topics

-**LAB** – Jupyter notebook to run for ECM to simulate constant voltage

-Quiz on how to use ECM to simulate constant voltage
-**LAB** – Jupyter notebook to run for ECM to simulate constant power
-Quiz on how to use ECM to simulate constant power
-Quiz on Simulate battery packs
-**LAB** – Jupyter notebook to run for Octave code to simulate PCM's

-Quiz on Octave code to simulate PCM's

-**LAB** – Jupyter notebook to run for Octave code to simulate SCM's
-Quiz on Octave code to simulate SCM's

Overall assessment on all the above topics

- Quiz on develop a load/battery co-simulator
- Assignment on how to Infer the information needed to develop a load/battery co-simulator based on the example taught.
- Assignment on how to Analyze vehicle/battery co-simulation block diagram to understand the dependencies of simulation variables.
- Quiz on Modelling ideal vehicle dynamins
  Quiz on practical limits to model of vehicle dynamics
  Quiz on calculating electric-vehicle range
  -**LAB** – Jupyter notebook to run for Octave code to set up EV simulation
  -**LAB** – Jupyter notebook to run for Octave code to conduct EV simulation
  -Quiz on Octave code to set up EV simulation and conduct EV simulation

  - **LAB – Capstone Project to** modify three sample Octave programs to create functions that can simulate temperature-dependent cells, battery packs built from PCMs, and battery packs built from SCMs.
  - Assignment – Programming Assignment for manually tuning an ESC cell model

Unit 3 – Introduction to Battery Management System

- Pre-requisite Quiz on Battery Boot Camp
- Quiz on battery terminology
- Quiz on parts of electrochemical cell
- Quiz on electro chemical cell storage and release energy
- Quiz on materials to use in electrochemical cell
- **Overall assessment on all the above topics**

- Quiz on lithium-ion cells
- Quiz on lithium-ion cells different from electrochemical cells
- Quiz on negative electrodes for lithium-ion cells
- Quiz on positive electrodes for lithium-ion cells
- Quiz on electrolytes and separators for lithium-ion cells
- Quiz on lithium to run out

Overall assessment on all the above topics

- Quiz on primary functions of a BMS
- Quiz on Modular design
- Quiz on Cell Voltage in a BMS
- Quiz on sense module temperature in a BMS
- Quiz on sense battery-pack current in a BMS
- Quiz on control contactors with a BMS

- Quiz on electrical isolation in a BMS

Overall assessment on all the above topics

- Quiz on BMS Protect the user and battery pack
- Quiz on BMS interface with other system components
- Quiz on BMS estimate SOC and SOH
- Quiz on Cell SOC and Battery-pack SOC
- Quiz on computing cell available energy and power
- Quiz on computing battery pack available energy and power
- Quiz on kinds of diagnostics must for a BMS report

Overall assessment on all the above topics

Unit 4 - AC Motor Control Components, MOSFET & Battery SOC Estimation

- Quiz on AC motor control
- Simulation of a Synchronous Boost Converter - Complete Assignment to Understand the tradeoff between voltage breakdown, switching time, and forward voltage drop in a power semiconductor device, Complete Assignment to Model switching loss using equivalent circuits
- Complete Assignment to Design gate drivers, Work on LTspice File: Synchronous Boost Converter, with associated driver, dead time generator, and PWM models

- Quiz on importance of a good SOC estimator
- Quiz on defining SOC
- Quiz on Estimating battery cell SOC
- **LAB** - This Jupyter notebook implements voltage-based methods for SOC estimation. This notebook implements two voltage-based SOC-estimation methods. The first one simply looks up cell terminal voltage under load in an OCV from SOC table. The second attempts to compensate for the effects of cell equivalent-series resistance

-Quiz on man and covariance
-Quiz on uncertainty of two unknown quantities
-Quiz on varying uncertain quantities
-**Overall assessment on all the above topics**

-Quiz on predict/correct mechanism of sequential probabilistic inference
-Quiz on Kalman-filter gain factor
-Quiz on six steps of generic probabilistic inference
-Quiz on three Kalman-filter prediction steps
-Quiz on three Kalman-filter correction steps
-Quiz on linear KF as a state estimator
-**Overall assessment on all the above topics**

-Quiz on Kalman filter with a linearized cell model
-**LAB** – Generate Correlated random vectors (15 Mins)
-Quiz on Octave code to generate correlated random numbers
-**LAB** – Write Code implementing linear Kalman filter (15 mins)
-Quiz on Octave Code to implement KF for linearized cell model
-Quiz on numeric robustness of Kalman filter
-Quiz on automatically detecting bad measurements with a Kalman filter
-Quiz on initialize and tune a Kalman filter
-Quiz on Linear KF and next steps

- Quiz on Non-linear variations to Kalman filters
- Quiz on three extended Kalman –filter prediction steps
- Quiz on three extended-Kalman-filter correction steps
- **LAB** – Write Simple EKF Example workout (20 Mins)
- Quiz on Simple EKF with Octave code

- L**AB** – Preparing to implement EKF on an ECM (15 Mins)
- Quiz on Preparing to implement EKF on an ECM
- **LAB** – Octave implementation of EKF to estimate SOC (30 Mins)
- Quiz on Octave implementation of EKF to estimate SOC
- Quiz on cell SOC estimation using an EKF and next steps
- Quiz on Sigma point methods
- Quiz on uncertain variables using sigma points
- Quiz on six sigma – point –Kalman filter steps
- **LAB** – Simple SPKF example with Octave code (20 Mins)
- Quiz on Simple SPKF example with Octave code
- **LAB** – Octave implementation of SPKF to estimate SOC (30 Mins)
- Quiz on Octave implementation of SPKF to estimate SOC
- Quiz on Cell SOC estimation using a SPKF and next steps
- Quiz on estimating SOC for battery packs
- Quiz on bar filters using an ECM

- Quiz on delta filters using an ECM
- **LAB** – Octave implementation of a bar-delta filter (30 Mins)
- Quiz on desktop validation as a method of predicting performance
- **Capstone Project**

  Part 1 - Tuning an EKF for SOC Estimation
  Part 2- Tuning an SPKF for SOC Estimation

Unit 5 :- Battery State-of –Health (SOH) Estimation & Mitigation of harmonics – (10 Hours)

- Quiz on cell ages
- Quiz on Negative-electrode aging processes at particle surface
- Quiz on Negative-electrode aging processes in bulk and composite electrode
- Quiz on positive-electrode aging processes
- **LAB** - This Jupyter notebook implements ### Simple method to estimate cell series resistance. This notebook executes the simple method presented in lesson 4.1.6 to estimate cell series **resistance**
- Quiz on cell voltage to changes in equivalent series resistance (ESR) (10 Mins)
  Quiz on sensitivity of cell voltage to changes in cell total capacity

  Overall assessment on all the above topics

- Quiz on using ordinary least squares to estimate total capacity
- **LAB** – How to find the ordinary least squares solution as a benchmark (10 Mins)
- Quiz on ordinary least squares solution as a benchmark
- **LAB** – Demonstrating the ordinary-least-squares solution computationally efficient (10Mins)
- Quiz on ordinary-least-squares solution computationally efficient
- **LAB** – Finding the solution to an weighted total-least-squares problem (10 Mins)
- Quiz on setting up weighted total-least-squares solution
- **LAB** – Confidence intervals on least-squares solutions (10 Mins)
- Quiz on Confidence intervals on least-squares solutions
  Overall assessment on all the above topics

- **LAB** – Simplifying the total-least-squares solution for cases having proportional uncertainties (10 Mins)
- Quiz on the total-least-squares solution for cases having proportional uncertainties
- **LAB** – Making simplifies solution computationally efficient (10 Mins)
- Quiz on Making simplifies solution computationally efficient
- Quiz on Defining geometry for approximate full solution to weighted total least squares
- Quiz on finding appropriate cost function for approximate full solution to AWTLS problem
- **LAB** – Finding solution to the AWTLS Problem (10 Mins)

- Quiz on AWTLS Problem
- **LAB** – Adding fading memory (10 Mins)
  Overall assessment on all the above topics
- **LAB** – Write Octave code to estimate cell total capacity (10 Mins)
- Quiz on estimate cell total capacity
- **LAB** – Demonstrating Octave code HEV: Scenario 1 (10 Mins)
- Quiz on Octave code HEV: Scenario 1
- **LAB** – Demonstrating Octave code HEV: Scenario 2-3 (10 Mins)

- Quiz on Octave code HEV: Scenario 2-3
- **LAB** – Demonstrating Octave code BEV: Scenario 1 (10 Mins)
- Quiz on Octave code BEV: Scenario 1
- **LAB** – Demonstrating Octave code BEV: Scenario 2-3 (10 Mins)
- Quiz on Octave code BEV: Scenario 2-3
  Overall assessment on all the above topics

- Quiz on Deriving SPKF method for parameter estimation
- Quiz on Deriving EKF method for parameter estimation
- Quiz on estimate states and parameters at the same time. Steps to do
- **LAB** – Robustness and Speed (1 hour)
- **LAB** – A Kalman filter approach to total capacity estimation (10 Mins)

- **Capstone Project Evaluation** – Students have learned several different total-capacity estimation methods. Some of these methods work better than others in general, but any method is only as good as the data you give it. In this project, students will explore a different way to determine the "x" and "y" data you use as input to the total-capacity estimation methods. (3 hr. 30 Mins)

  1.Jupyter notebook for capstone project integrated
  2.Tuning xLS algorithms for total capacity estimation

- Quiz on Universal-Input Boost Low-Harmonic Rectifier
- Quiz on DCM Flyback as PFC Rectifier
- Quiz on Energy Storage Capacitor in a Flyback PFC
- Quiz on Boost PFC Rectifier Control Loops
- Quiz on Comparison of PFC Rectifiers

Test Project :-

Design 48v 36Ah LIFEPO4 battery pack for the dimension of 430mm(L) x 15mm(B) x 160mm(H) and develop the control circuit for sensing the individual array temperature with OV and UV protection with minimum harmonic content also calculate the SOC and SOH using Octave model

COURSE OUTCOMES:

Students will be able to,

- Arrange the Cell array for various power ratings
- Measure the Voltage, Current and temperature of individual cell array
- Estimate the fault current during short circuit and overload
- Develop the galvanizing isolation for high and low side MOSFET
- Estimation of SOC and SOH
- Estimation of SOC and SOH
- Develop protection circuit for fast charging
- Mitigation of harmonics in EV charging system

Course Links:

1. https://www.coursera.org/learn/people-technology-and-the-future-of-mobility
2. https://www.coursera.org/learn/equivalent-circuit-cell-model-simulation
3. https://www.coursera.org/learn/battery-management-systems
4. https://www.coursera.org/lecture/motors-circuits-design/5-ac-motor-control-components-Mws6I
5. https://www.coursera.org/lecture/converter-circuits/sect-4-2-2-1-power-mosfets-a1NBr
6. https://www.coursera.org/learn/battery-state-of-charge
7. https://www.coursera.org/learn/battery-state-of-health
8. https://www.coursera.org/learn/modeling-and-control-of-single-phase-rectifiers-and-inverters

SB8010 **SMART ENERGY GRID** **LT P C**
1 0 2 2

COURSE DESCRIPTION:

Since the early 21st century, opportunities to take advantage of improvements in electronic communication technology to resolve the limitations and costs of the electrical grid have become apparent. Technological limitations on metering no longer force peak power prices to be averaged out and passed on to all consumers equally. In parallel, growing concerns over environmental damage from fossil-fired power stations have led to a desire to use large amounts of renewable energy and Smart Grid plays a vital role in it.

In this course, students will get exposed to Smart grid Fundamentals, Architecting smart grid technologies, M2M & IOT Interface design and protocols for embedded systems. Students will also work on guided projects in Azure IoT Hubs.

COURSE OBJECTIVE:

Students will be able to understand and work on smart grid technologies and its potential in different types of power sectors such as power generation, transmission, and distribution.

They will get to Architect Smart IoT Devices, programming with IOT Boards, M2M & IoT Interface Design & Protocols for Embedded Systems because it's essential that an IoT Project that can monitor and manage the energy consumption of your Devices with a Smart Energy Meter and cloud , which tells you the amount of energy consumed by a particular device. Smart grid is one of the essential features of smart city. It provides a communication between the provider and consumer." And using Arduino for IoT based Smart Grid Systems:

COURSE CURRICULUM

UNIT I INTRODUCTION TO ELECTRIC POWER SYSTEMS & SMART GRID 3T+6P

Theory component:

- Basic Electricity – *[6 Videos, 2 Readings,6 Quizzes]*
- Generation, Transmission, & Distribution – *[4 Videos, 1 Reading,5 Quizzes]*
- System Design & Switching – *[3 Videos, 1 Reading, 4 Quizzes]*
- Renewable Energy & Smart Grid Technologies – *[4 Videos, 4 Readings & 4]*

Practical/Lab component: NA

UNIT II INTRODUCTION ARCHITECTING SMART IOT DEVICES 3T+6P

Theory component:

- Embedded Systems - *[7 Videos,14 Readings ,4 Quizzes]*
- Problems & Failures of Systems - *[6 Videos,20 Readings & 5 Quizzes]*
- System Life Cycle - *[6 Videos, 15 Readings ,4 Quizzes]*

Practical/Lab component: NA

UNIT III ARCHITECTING SMART IOT DEVICES 3T+6P

Theory component:

- Hardware & Software for EmS - *[7 Videos, 19 Readings, 5 Quizzes]*
- RTOS – *[6 Videos ,26 Readings & 5 Quizzes]*
- System finalisation– *[6 Videos ,28 Readings & 3 Quizzes]*
- Low Power - *[6 Videos, 3 Readings,1Quiz]*

Practical/Lab component: NA

UNIT IV INTRODUCTION AND PROGRAMMING WITH IOT BOARDS 3T+6P

Theory component:

- Introduction to IOT - *[2 Videos, 2 Quizzes]*
- Networking Technologies for IOT - *[2 Videos, 2 Quizzes]*
- IOT Programming with Arduino- *[6 Videos, 2 Quizzes]*
- IOT Programming with Raspberry Pi - *[5 Videos, 3 Quizzes]*
- IOT Programming with ARTIK Board - *[4 Videos, 3 Quizzes]*

Practical/Lab component: NA

UNIT V M2M & IOT INTERFACE DESIGN & PROTOCOLS FOR EMBEDDED SYSTEMS 3T+6P

Theory component:

- Intro Introduction to M2M & IoT- *[8 Videos, 1 Reading, 1 Quiz]*
- Cloud for IOT - *[2 Videos, 2 Quizzes]*
- Communications Protocols- *[5 Videos, 1 Quiz]*
- Other Cloud and IoT Elements - *[7 Videos, 1 Quiz]*

Practical/Lab component: NA

- *Assignment Quiz on M2M & IoT, Cloud Architectures, UML and Architecture Patterns (10 Mins)*
- *Pre-Project Preparation and AWS Account Acquisition (10 mins)*
- *Graded Project Assignment on Simple AWS IoT Connection (1 hr)*
- *Graded Project Assignment on Extended AWS IoT Connections (1 hr)*
- **TOTAL : 45 PERIODS**

Mandatory Project work

- *Pre-Project Preparation and AWS Account Acquisition (10 mins)*
- *Graded Assignment on Simple AWS IoT Connection (1 hr)*
- *Graded Assignment on Extended AWS IoT Connections (1 hr)*

Other Stand-alone Guided Projects: (4 Hours)

- *Create an IoT hub & IoT device in Azure and use a Raspberry Pi web simulator to send telemetry data to the IoT hub*
- *Configure Routing in Azure IoT Hub - Create an IoT hub and register a device in IoT hub, Configure message routing in Azure IoT Hub, Create an Azure Storage account to store the incoming sensor data.*
- *Build Device Messaging and Communication in Azure IoT Hub - Create and configure Azure IoT hub, demonstrate to send device-to-cloud and cloud-to-device messages & learn to use message routing with Azure IoT Hub.*
- *Processing IoT Hub data streams with Azure Stream Analytics - Create an IoT hub and register a device in IoT hub, Create stream analytics job with IoT hub as input and Azure storage as output, Will use raspberry pi online simulator to send streaming data to the IoT hub.*

Test Project:-

Develop an SQL database for the smart energy meter using AWS cloud or Configure Routing in Azure IoT Hub which will log the data of voltage, current, maximum demand and power factor

List of Software Students are exposed to

- Microsoft Azure
- Azure IoT Hub

Duration of availability of Licensed Software to Students

- For the entire Semester *(Could be extended if required for specific candidates)*

List of consumables that will be given to per student

- License for accessing respective Courses
- Orientation on portal access
- Doubt clarification session based on need basis
- Automatic Graded Assessment reports
- Access to discussion forums to relevant courses/steams

Student Assessment Plan

- *Every Sub-units will have a Quiz and every Unit will have an overall Graded Quiz other than Lab exercise and Peer Graded Assignments*
- *All Assessments are online based , auto-graded & Peer Graded*
- *If a students does not score the required minimum of 80% , he will be asked to retake the tutorial and attempt the Quiz again.*

Unit 1 – Introduction to Electric Power Systems & Smart Grid

- Quiz on Basic Electricity Concepts
- Quiz on Basic Electric properties
- Quiz on Simple Circuits
- Quiz on ohm's Law
- Quiz on AC Current
- Quiz on ohm's Law

Overall Graded assessment on all the above topics

- Quiz on Generation, Transmission, & Distribution
- Quiz on Generation
- Quiz on Transmission & Sub transmission

Overall Graded assessment on all the above topics

- Quiz on System Design & Switching : Circuit Breakers
- Quiz on Switches
- Quiz on Double-Busbar & Switching Sequence

Overall Graded assessment on all the above topics

- Quiz on Renewable Energy & Smart Grid Technologies: Smart Grid Risks
- Quiz on Smart Grid, utilities & Consumers
- Quiz on Smart Grid & the Environment
- Quiz on Renewable Energy

Overall Graded assessment on all the above topics

Unit 2 – Introduction Architecting Smart IOT Devices

- Quiz on Embedded System's markets
- Quiz on EmS Characteristics
- Quiz on parallel Executions
- Quiz on Electronic Time
- Quiz on Abuse
- Quiz on Embedded systems Failure
- Quiz on EmS Success rate
- Quiz on Build or Buy
- Quiz on EmS Complexity

- Quiz on Life Cycle Basics
- Quiz on Architectural Design
- Quiz on Model-based Design
- Quiz on SysML

Unit 3 - Architecting Smart IOT Devices

- Quiz on Processors
- Quiz on Boards
- Quiz on networks
- Quiz on Software Components
- Quiz on IoT Components
- Quiz on XXS to XXL
- Quiz on Real-Time Scheduling
- Quiz on Synchronisation and Communication

- Quiz on Device Drivers
- Quiz on Multithreading Design
- Assignment & Discussion prompt – Turn on your smartphone into a BB gateway
- Quiz on Development tools & Environments
- Quiz on Debugging Basics
- Quiz on Debugging specials and Code Tuning
- Quiz on Low Power

Unit 4– Introduction and Programming with IoT Boards

- Quiz on IoT
- Quiz on IoT use cases
- Quiz on Wired & Wireless networking technologies
- Quiz on Wireless Personal Area Networking technologies
- Quiz on Arduino
- Quiz on Arduino
- Quiz on Programming with Arduino
- Quiz on Raspberry Pi
- Quiz on Programming with Raspberry Pi - 1
- Quiz on Programming with Raspberry Pi - 2
- Quiz on ARTIK
- Quiz on Programming with ARTIK

Unit 5– M2M & IoT Interface Design & Protocols for Embedded Systems

- Quiz on M2M & IoT, Cloud Architectures, UML and Architecture patters
- Quiz on IoT Application Protocols, Cloud for IoT, AWS, AWS IoT
- Graded Project Assignment on Simple AWS IoT Connections
- Quiz on low-Level Protocols, M2M Protocols, LPWANs for IoT
- Graded Project Assignment on Extended AWS IoT Connections
- Quiz on AWS alternatives, IoT Security, Message Queuing, APIs, Microservices

Other Stand-alone Guided Projects Evaluation :

⇒ Create an IoT hub & IoT device in Azure and use a Raspberry Pi web simulator to send telemetry data to the IoT hub.

⇒ Configure Routing in Azure IoT Hub - Create an IoT hub and register a device in IoT hub, Configure message routing in Azure IoT Hub, Create an Azure Storage account to store the incoming sensor data.

⇒ Build Device Messaging and Communication in Azure IoT Hub - Create and configure Azure IoT hub, demonstrate to send device-to-cloud and cloud-to-device messages & learn to use message routing with Azure IoT Hub.

⇒ Processing IoT Hub data streams with Azure Stream Analytics - Create an IoT hub and register a device in IoT hub, Create stream analytics job with IoT hub as input and Azure storage as output, Will use raspberry pi online simulator to send streaming data to the IoT hub.

Test Projects :-

Develop an SQL database for the smart energy meter using AWS cloud or Configure Routing in Azure IoT Hub which will log the data of voltage, current, maximum demand and power factor

Project Sample Structure

Documentary Evidence –

1. https://www.coursera.org/learn/electric-power-systems
2. https://www.coursera.org/learn/iot-devices
3. https://www.coursera.org/learn/iot-architecture
4. https://www.coursera.org/learn/introduction-iot-boards
5. https://www.coursera.org/learn/m2m-iot-interface-design-embedded-systems

Coursera Guided Projects –

1. https://www.coursera.org/learn/getting-started-with-azure-iot-hub
2. https://www.coursera.org/learn/configure-routing-in-azure-iot-hub
3. https://www.coursera.org/learn/build-device-messaging-and-communication-in-azure-iot-hub
4. https://www.coursera.org/learn/processing-iot-hub-data-streams-with-azure-stream-analytics

COURSE OUTCOMES:

Students will be able to,

- Explain the difference between parallel and series of circuits.
- Analyze a basic DC circuit by calculating sum resistances.
- Determine whether a transformer is step-up or step-down.
- Identify the segments of the electrical power system.
- Explain the difference between generation, transmission and distribution in an electrical system
- Recognize the common the distribution voltages
- Identify common electrical power components
- Identify and define what a circuit breaker is.
- Differentiate between low, medium and high circuit breakers.
- Evaluate the difference between switches and circuit breakers.
- Identify reasons that fossil fuels are unsustainable
- Differentiate the parts of a smart grid and identify the benefits of each part
- Identify reasons that renewable energy sources are sustainable.
- Evaluating the embedded system market
- Outlining the characteristic of real time embedded systems
- Discuss the response of embedded system in the case of simultaneous events
- Discuss the notion of time and how it will be used in the embedded system
- Metaphoric overview of the methods and means to make a project operational
- Outline the problems associated with existing embedded systems and system hacking
- Analyze different types of failure and its effect on the embedded system performance
- Evaluate the system complexity and ways to deal with it
- Analyze basics of embedded system lifecycle and challenges associated with it
- Outline the need of architectural design and its applicability at system or drivers level
- Exemplify the importance of model based designs and ways to do it
- Distinguish between UMl and SysML for model based approach and tools to support it
- Evaluating the embedded components used for application specific design
- Able to decide whether components are ready to use or they need some configuration
- Evaluate the consquences of component changes to design or software
- Discuss the Intellectual property and licensing implications
- Apply architectural work at application
- Evaluate the characteristics while choosing a processor
- Criteria available to select printed circuit boards for IoT
- Explore the networking technologies used in embedded systems today focusing specially on IoT
- Explore software components for embedded system
- Evaluate the IoT market
- Evaluate the characteristics of different operating systems for embedded applications
- Outlining the different types of scheduling policies of real time operating systems
- Describing the synchronization and communication features of operating systems required for multitasking aspects
- Exploring the rules for multithreading design
- Outline the challenges in embedded software development
- Evaluate the debugging techniques and code tuning for performance
- Analyze the types of testing to validate the device functioning
- Discover the importance of the security of hardware and software
- Outline the required tools and debugger for embedded system development
- Analyze the methods of simulation to validate the device functioning
- Discover the ways of elimination of threats
- Conceptualize the meaning of low power in embedded system
- Outline the requirements of power and energy optimization
- To understand the basic elements of IoT, which is the general architecture and technologies involved.
- To find IoT use cases and explain how IoT devices work.

- To understand the key networking technologies used in IoT.
- To understand wireless personal area networks.
- To understand what Arduino is and its hardware and software components.
- To understand how to use Arduino board and how to program it.
- To understand what Raspberry Pi is and its hardware and software components.
- To understand how to use Raspberry Pi board and how to program it.
- To understand what ARTIK board is and its hardware and software components.
- To understand how to use ARTIK board and how to program it.
- Define and assess importance of M2M and IoT to modern development
- Understand, compare, contrast cloud architecture elements
- Be able to use UML and Use Cases in software design
- Apply IoT design to AWS-connected coding examples
- Recognize sources for architectural design and patterns support
- Apply IoT design to AWS-connected coding examples
- Review, compare, contrast common IoT application protocols
- Recognize key elements of cloud support for IoT devices and systems
- Review AWS services, costs, and certification
- Review specific elements of AWS IoT-related services
- Apply IoT design to AWS-connected coding examples
- Review, compare, contrast common low-level communication protocols
- Review, compare, contrast M2M wired and wireless protocols
- Review, compare, contrast low-power WANs for IoT use
- Apply IoT design to AWS-connected coding examples
- Consider alternatives to AWS for IoT support
- Understand security concerns and tools for IoT systems
- Consider and compare message queuing tools and patterns
- Consider API design and best practices for IoT systems
- Review the application of microservice architecture to IoT systems

Other Stand-alone Guided Projects: (4 Hours)

- Create an IoT hub & IoT device in Azure and use a Raspberry Pi web simulator to send telemetry data to the IoT hub
- Configure Routing in Azure IoT Hub - Create an IoT hub and register a device in IoT hub, Configure message routing in Azure IoT Hub, Create an Azure Storage account to store the incoming sensor data.
- Build Device Messaging and Communication in Azure IoT Hub - Create and configure Azure IoT hub, demonstrate to send device-to-cloud and cloud-to-device messages & learn to use message routing with Azure IoT Hub.
- Processing IoT Hub data streams with Azure Stream Analytics - Create an IoT hub and register a device in IoT hub, Create stream analytics job with IoT hub as input and Azure storage as output, Will use raspberry pi online simulator to send streaming data to the IoT hub

Test Project:- Develop an SQL database for the smart energy meter using AWS cloud or Configure Routing in Azure IoT Hub which will log the data of voltage, current, maximum demand and power factor

Course Links:

1. https://www.coursera.org/learn/electric-power-systems
2. https://www.coursera.org/learn/iot-devices
3. https://www.coursera.org/learn/iot-architecture
4. https://www.coursera.org/learn/introduction-iot-boards
5. https://www.coursera.org/learn/m2m-iot-interface-design-embedded-systems

Stand-alone Guided projects links:

1. https://www.coursera.org/learn/getting-started-with-azure-iot-hub
2. https://www.coursera.org/learn/configure-routing-in-azure-iot-hub
3. https://www.coursera.org/learn/build-device-messaging-and-communication-in-azure-iot-hub
4. https://www.coursera.org/learn/processing-iot-hub-data-streams-with-azure-stream-analytics

SB8011 **INDUSTRY 4.0** **L T P C**
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Table of Contents:

In response to the EOI we now intend to submit a proposal for onboarding us as a training partner of TNSDC under the Naan Mudhalvan program.

Part - 1: Course Overview:

Course Title: Industry 4.0

Course Description:

With Industry 4.0 bringing revolutionary changes to various industries, businesses are looking to adopt technologies like Data Analytics, the Industrial Internet of Things (IIoT), and Augmented Reality (AR/VR) to improve their manufacturing competitiveness. Therefore, it is crucial to stay abreast of the changes happening in the industry. This program educates and trains students on the fundamentals of Industry 4.0, the underlying technologies, digital transformation, change management, and improvement strategies.

Course Objective:

1. To train and equip individuals with the basic technologies behind Digital Transformation.
2. To Analyze and utilize the building blocks of Industry 4.0.
3. To Utilize and create the key technologies involved in Industry 4.0, change management, and implementation strategies.

Course Outcomes:

On completion of the course, a group of students (4 Nos) will be able to

LO1: Identify the location of their institute and calculate the energy consumption and utilization of the identified place.
LO2: Design a dashboard for real-time monitoring of electricity consumption and utilization of the identified place using node MCU.
LO3: Connect appropriate sensors with all resources to be monitored and communicate the real-time data to the central server.
LO4: Calculate the wastage due to poor utilization of the resources and prepare the wastage report for the identified place.
LO5: Prepare a plan and schedule for preventing wastages based on the real-time data monitored.
LO6: Prepare an ROI report for the energy saved.

Course Hours and Mode of Delivery:

Online Theory No. of Hours	Online Practical/Hands-on No. of Hours	On Campus Theory No. of Hours	On Campus Practical No. of Hours
15	30	8	8

Student Assessment 1:

Students will have to identify a place with electrical utilities, select sensors, electric power or other industrial parameters, incorporate them in the electrical utilities, send sensor data to the cloud server through node MCU, and create a dashboard to visualize the real-time data received from sensors.

Student Assessment 2:

Students will have to measure the energy consumed by various electrical utilities for the identified place in terms of money spent, prepare a waste reduction plan for reducing energy wastage based on the data received, and implement energy-saving measures. Prepare an ROI report based on the waste reduced.

Part - 2: Course Curriculum

Unit 1: **3T+6P**

Introduction to Industry 4.0, Digital Transformation & Smart Manufacturing, and Building Blocks of Industry 4.0

Theory component:

Overview of Industry 4.0 and Evolution in Various Industries - Opportunities for Digital Transformation - Traditional Vs Smart Manufacturing - Key Concepts and Drivers for Digital transformation - Industrial Revolutions (1.0 to 4.0) - Additive Manufacturing - Augmented Reality/Virtual Reality - Autonomous Robots - Big Data and Analytics - The Cloud - Horizontal and Vertical System Integration - The Industrial Internet of Things (IIoT) - Digital Twin - Cybersecurity

Practical component:

Identify various wastes enterprise level in manufacturing organizations and make the list of it and analyze the source of it and list its root causes.

Unit 2: **3T+6P**

Opportunities in Industry 4.0, Transformation & Change Management and Key Uses of Smart Manufactu ring

Theory component:

Risk of Data security - IT Infrastructure - Legacy machines - Operational Excellence - Competitive Edge - Increased Work Safety - Flexible Production - Customer Satisfaction - Transforming Customer Experience, Operational Processes, and Business models - Change Management and its Theories - Vision and Strategies - Role of Leadership in Digital Transformation - Adoption Issues and Implementation Challenges - AR for Maintenance and Training - Predictive Maintenance - Virtual Training - Cobots in Manufacturing - Real-Time Dashboards and Alerts

Practical component:

Propose a solution to eliminate each waste with industry 4.0 technologies learned and do process mapping.

Unit 3: **3T+6P**

Implementing Industry 4.0 for Smart Manufacturing, Introduction to Smart Factories, Its Use Cases and Examples

Theory component:

Typical Industrial Set-up - Implementing Industry 4.0 - Industry Wise Pain Points and Challenges - Key Performance Indicators in Industries - Connected Manufacturing Solutions: Use Cases and Examples - Connected Supply Chain: Use Cases and Examples - Manufacturing Analytics: Concepts, Examples and Use Cases

Practical component:

1. Creation of Key Performance Indicator (KPI) Dashboard for an Automotive Manufacturing company.
2. Understand the key KPIs and their calculations.
3. Perform Vertical Integration.
4. Perform conditional monitoring of process and quality parameters.
5. Create a working KPI dashboard based on production data.
6. Create a manufacturing dashboard using Industrial IoT tools.

Unit 4: **3T+6P**

Impact of Industry 4.0 on Environment & Sustainability and Overview of Digital Twins

Theory component:

Environmental Management in Industry 4.0 - Technologies for Environmental Management - Challenges in Implementing Industry 4.0 for Environment and Sustainability - Introduction to Digital Twins and Their Functions - Role of Digital Twins in Smart Manufacturing - Digital Twins Built on IoT Platform - Implementation of Digital Twins - Applications of Digital Twins in Automotive Industry - Future Trends

Practical component:

Hands-on project demo using IOT platform that mimics the real world scenario.

Unit 5: **3T+6P**

Smart Machines and Digital Industry Transformation

Theory component: Introduction to Smart Machines - Evolution of Smart Machines - Building Blocks of Smart Machines - Sensors and Signal Processing - Controllers in Smart Machines - Smart Machines and Future Technology - Product Life Cycle Management - Material Requirement Planning - Manufacturing Process Management - Manufacturing Execution System - Enterprise Resource Planning

Practical component:

1. ROI case study
2. Prepare an ROI report based on the Cost of Technology

Mandatory Project Work:

Mentioned in Addendum - 1

Detailed Unit Wise plan:

Mentioned in Addendum - 2

List of Software Students are exposed to

1. Micro Python programming
2. Things board
3. Wokwi
4. Google Sheets

Duration of availability of Licenced Software to Students

The software that we use is open source hence it is available anytime

List of Hardware Students are exposed to

1. ESP 32 (Virtually simulated)
2. HCSR-04 (virtually simulated)

List of consumables that will be given per student

1. LMS access is given to all the students
2. All pre-recorded lecture videos will be given to the student

Part - 3:

Student Assessment Plan

- Every unit is delivered over a couple of weeks and every week has assessments attached to it. (Addendum - 2)
- The Assessments are a combination of Self-graded and Manually graded questions.
- Both Skill-Lync and college faculties will be involved in grading the assessments. (Addendum 1 and 2)

Mid-term/Unit Assessment 1:
Shared in Addendum - 2

Mid-term/Unit Assessment 2:
Shared in Addendum - 2

End/Exit Assessment:

Shared in Addendum - 1

Student Assessment 1:
Students will have to identify a place with electrical utilities, select sensors, electric power or other industrial parameters, incorporate them in the electrical utilities, send sensor data to the cloud server through node MCU, and create a dashboard to visualize the real-time data received from sensors.

Student Assessment 2:
Students will have to measure the energy consumed by various electrical utilities for the identified place in terms of money spent, prepare a waste reduction plan for reducing energy wastage based on the data received, and implement energy-saving measures. Prepare an ROI report based on the waste reduced.

Addendum - 1: Project works for Industry 4.0

Mandatory Project works:

Project 1

Project Title: Use of I4.0 for operational improvements

Project description: The project aims to study the impact of implementing Industry 4.0 technologies to eliminate each potential waste identified by the manufacturing organization

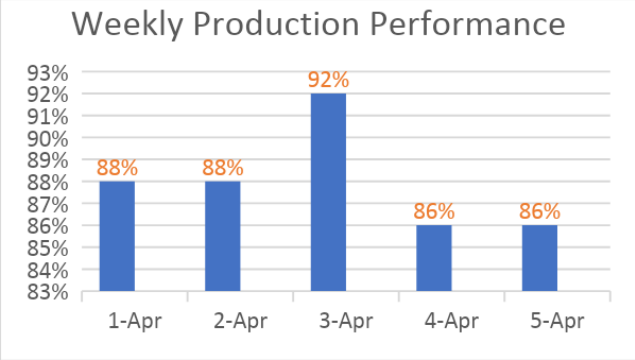
Project Outcomes: The students are able to Identify 7 wastes in manufacturing and propose IOT technologies for data collection and analysis to prioritize to eliminate potential causes.

Software Used: Microsoft Excel

Project Deliverables:

1. A Detailed list of seven wastes in manufacturing
2. A detailed description of each waste with diagram
3. List of technologies re-searched per waste along with a minimum of one case study
4. List of vendors who provide the technology solution
5. Vendor comparison report
6. ROI report based on the cost of technology and the waste in manufacturing

Project solution dashboard



Project 2

Project Title: A project on creating a Key Performance Indicator (KPI) dashboard for an Automotive Manufacturing Company

Project description: The project aims to analyze the key performance indicator of the manufacturing processes and propose the solution to improve the same and cost involved in it and also prepare ROI report.

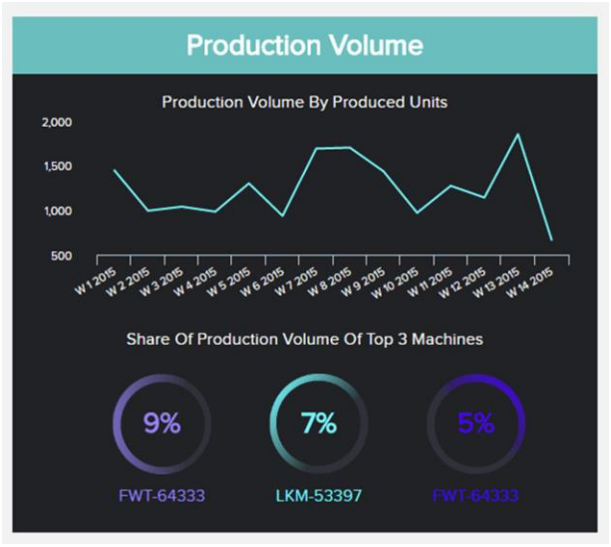
Project Outcomes: The students can measure the objectives of the manufacturing processes and plot the KPI performance of the organization.

Software Used: Microsoft Excel

Project Deliverables:

1. Calculating key KPIs
2. Performing Vertical Integration
3. Condition monitoring of process and quality parameters
4. Creating a working KPI dashboard on MS Excel with production data

Project Solution Template:



Project 3

Project Title: A project on creating real-time process monitoring of temperature and humidity manufacturing industry using an Open source IoT platform.

Project description: The project aims to monitor real-time temperature and humidity monitoring dashboards using the Thingsboard IoT platform.

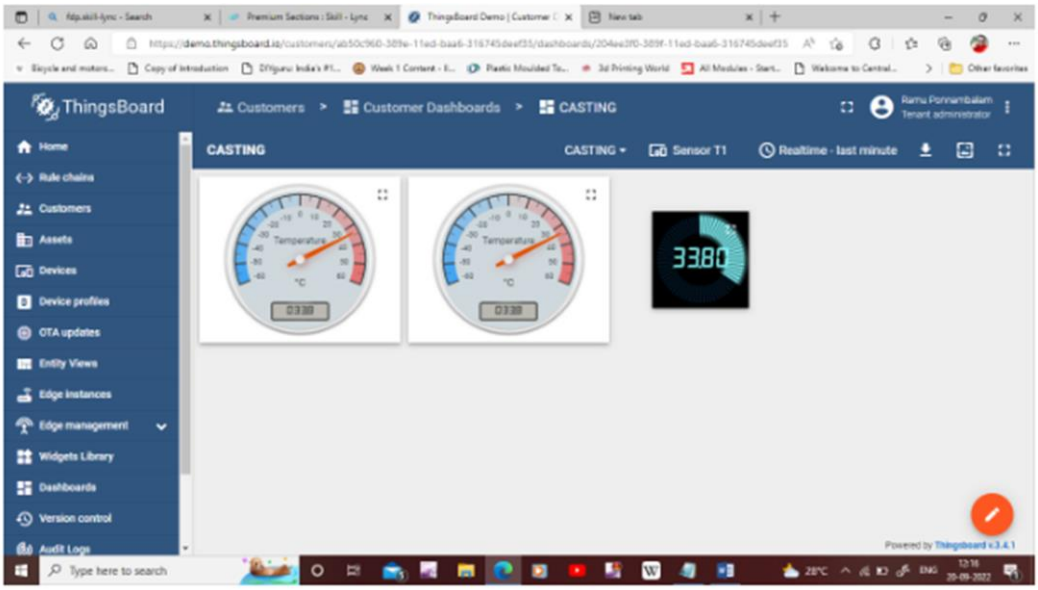
Project Outcomes: The students can able to the identification of the right devices like sensors and use connect them with the things board MQTT platform for real-time monitoring of the manufacturing processes

Software used: Thingsboard

Project Deliverables:

1. Analyze different IoT protocols and things board open source platform
2. Selection of sensors and configure the same
3. Create the dashboard
4. Real-time monitoring of the manufacturing process with data.

Project Solution Template:



Project 4

Project Title: Use of Industry 4.0 for Monitoring Vehicle Fuel level from a central fleet management group

Project description: The project aims to real-time monitoring of the Vehicle fuel level dashboard using open source ***WOKWI*** IoT platform.

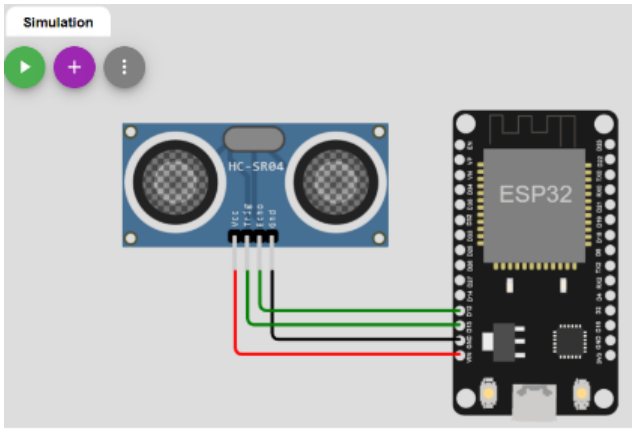
Project Outcomes: The basic principle involved in level monitoring using ultrasonic sensor Interfacing sensors to NodeMCU (ESP32) hardware. The need for MQTT publishing services and the overall implementation with python programming

Software Used: WOKWI

Project Deliverables:

1. Enable connection and configuration of ESP32 (NodeMCU) board
2. Real-time fuel level monitoring with one case study
3. Simulation and verification with a reference value.

Project Solution Template



Python Program Example

from hcsr04 import HCSR04

from machine import Pin, I2C

import network

import time

from machine import Pin

import dht

import ujson

from umqtt.simple import MQTTClient

 # MQTT Server Parameters

MQTT_CLIENT_ID = " Measurement of Object Distance"

Addendum - 2: Unit Content with Assessments, Challenges, Midterms, and Exit Assessments:

apping of Outcomes with Assessments:

Unit - 1:

Week #	Day#	Title	Table of Contents	Video Title to Watch	Video Duration	Unit Assessment	Outcome
1	Day 1	Overview of Industry 4.0	Introduction to Industry 4.0 and Evolution in Various Industries	Introduction to Industry 4.0 - Part 1	0:20:00	1. Search for 5 companies, that implemented smart manufacturing in their manufacturing plant, collect the below details 2. What benefits did these companies achieve? 3. Why smart manufacturing is a future? 4. Why MSME fails to adopt disruptive change early?	1. Practical knowledge about the companies that have implemented smart manufacturing. 2. Analyze the advantages and disadvantages of digital transformation 3. The literature on smart manufacturing will give the students a better idea about how it is better than traditional manufacturing and smart manufacturing 4. Deals with disruption and how its resistance can prove to be costly for the company.
	Day 2			Introduction to Industry 4.0 - Part 1	0:20:00		
	Day 3			Evolution in Various Industries	0:20:00		
2	Day 4	Introduction to Digital Transformation & Smart Manufacturing	Explore how disruption happens Finding new opportunities for digital transformation Traditional Vs Smart Manufacturing Key concepts of digital transformation Drivers for Digital transformation	New Opportunities in Digital Transformation	0:14:31	1. List the 5 vendors available for each industry 4.0 block in the market. (Compare each technology solution across 5 vendors, Comparison should have features, cost, and scalability details, What challenges these vendors are facing to convince customers) 2. Explain development tools and resources to be used to develop each building block of industry 4.0. details required as below for each. (List of software tools, List of hardware, List of cloud technologies, Network technologies (physical or Virtual network)) 3. Research & explain one case study for each building block of Industry 4.0, each case study should contain the below details (Company name, Problem identified, Results achieved in numbers (%, etc))	1. Practical industrial knowledge about the Technologies and their current market rates. 2. Reiteration of the I4.0 technologies and detailed information regarding the implementations and requirements of each. 3. Available case studies will give a more detailed picture of the Industry 4.0 technologies and the relevant problems solved, providing an objective-oriented idea to the students.
	Day 5			Traditional Vs Smart Manufacturing	0:21:41		
	Day 6			Key Concepts of Digital Transformation	0:27:08		
	Day 7			Drivers for Digital Transformation	0:13:19		
3	Day 8	Building Blocks for Industry 4.0	Industrial Revolutions (1.0 to 4.0) Additive Manufacturing Augmented Reality/Virtual Reality Autonomous Robots Big Data and	Industrial Revolutions (1.0 to 4.0) and Additive Manufacturing	0:18:59	1. Draw an architecture diagram for the below requirement "A company would like to connect their manufacturing line in IIoT on the cloud, they have 3 lines, manufacturing line is having conveyor with product followed through two heating oven after finishing, the company wants to monitor the temp of oven and control oven if temp. Exceed 150C, and also alert users with data if any deviation, also they would like to monitor run time and downtime of line, products are moving on the conveyor, please propose a proper gateway, along with sensors with make and model. Also cloud platform.	1. The student will learn the It infrastructure in the syllabus and through the architecture diagram he/she will get a chance to create the same and in that process will analyze IT infrastructure and will apply the technical concepts in this assignment. 2. The student will learn, In the unlikely event of hacking in the company, How an efficient IT infrastructure can survive. The practical situation will provide a much better idea regarding this to the student. 3. The Covid 19 being a volatile
	Day 9			Augmented Reality/Virtual Reality and Autonomous Robots	0:29:00		

	Day 10		Analytics The Cloud Horizontal and Vertical System Integration The Industrial Internet of Things Digital Twin Cybersecurity	Big Data Analytics, the Cloud, and Horizontal & Vertical System Integration	0:22:36	Draw complete architecture with sensors, gateways & communication protocol, and a simple user dashboard. 2. Refer to General Data Protection Regulation (GDPR). Which type of data is vulnerable and why? Also, explain how you will act on the below Incident. A hacker hacks the company's IT infra network via a Phishing email, on this phishing email, one of the employees clicked and opened the door for the hacker. Now your IIoT network is in the same VLAN as the IT network, so you have 24 hours till a hacker breaches the IIoT network. Please list your actions and why you will take those actions during this cyber attack. 3. In this Covid pandemic to ensure social distancing in offices and on the shop floor, please recommend technologies with explanations and along with case studies.	the situation demands flexibility and quick thinking and disruptive technologies to be implemented. This Challenge will provide the students with such an opportunity to explore unconventional ideas.
	Day 11			Industrial IoT, Digital Twin, Cybersecurity	0:12:52		

Unit - 2:

Week #	Day#	Title	Table of Contents	Video Title to Watch	Video	Unit Assessment	Outcomes:
4	Day 12	Challenges & Opportunities in Industry 4.0	A Gap in Technical Skills Risk of Data security IT Infrastructure Legacy machines Change management Operational excellence Competisales edge Increased work safety Flexible production Customer satisfaction	IT Infrastructure, Data Security and Legacy Machines	0:27:06	1. One of the 2-wheeler manufacturing companies would like to transform the customer experience to increase their sales. They are looking for a solution so that customers can experience This 2-wheeler before they buy it, and also after selling they would like to ensure and update their customers about any upcoming part failure or low performance. Please recommend a solution with technology, it should include a detailed analysis of which sensors, and which technology you are proposing. One of the companies has a manufacturing plant of 120 machines, presently they are entering machine stoppages in regular paper log books per machine, which include total downtime, with the reason for downtime, here downtime refers to when the machine stops. And after the shift end supervisor collects all these data and summarizes them in one master paper log book. Then later this data is being entered by a data entry operator in excel. And then later production manager does analysis in excel. This whole process takes 1-2 days. This means the report is available after 2 days of production, which does not make sense to take action in a real-time shift and also much paperwork. Please recommend digitization solutions to reduce these days, and to act in real-time	1. The preventive maintenance and condition monitoring in the syllabus are kept in mind while designing this challenge. This challenge demands students to think and come up with a practical idea to solve a relevant industrial problem. The need for digital transformation and how it transforms the operational processes. The roadmap for the digital journey can be visualized through this challenge and could be analyzed with a practical example.
	Day 13			Operational Excellence, Flexible Production and Customer Satisfaction	0:22:43		

						in shifts to take action. Please draw architecture, and also screen dashboard if any.	
5	Day 14	Transformation & Change Management, Adoption issues and implementation challenges	Transforming Customer Experience Transforming operational processes Transforming business models Change management Key theories of change management Vision & strategies Role of leadership in digital transformation Adoption issues and implementation challenges Understanding your organization's readiness for digital transformation Roadmap to make the digital journey successful and sustaining it	Transforming Customer Experience, Operational Processes and Business Models	0:16:34	1, One of the companies is in urgent need of an operator skill set, they have recruited 70 operators, but the company cannot afford 1 month training lead time because they have got huge volume customer order to deliver and they need to deploy this new manpower in shopfloor in 1 week, please recommend technology solution to make this possible along with how this solution will work, Explain 3 case studies for the recommended solution. 2. In nuclear power its health safety is Hazardous to go inside the reaction chambers for inspection, company is looking for a digital solution to overcome this problem without entering the chamber. Please recommend a solution and also explain how it will work. Also, Explain 3 case studies for the recommended solution. 3. In one of the bottle-making machines, product inspection is done by sampling 10 bottles out of 1000 Bottles. Recently customer complaints have piled up and the company is looking to ensure 100% online inspection on the conveyor itself defective parts should be pushed into the rejection container, which means inspecting every bottle which is produced. But it cannot be done by a human being because the conveyor speed is 2 bottles/second. Please recommend a solution and also explain how it will work. Also, Explain 3 case studies for the recommended solution.	1. The topics like AR and VR in the syllabus are included in the challenge and the students are provided with a practical challenge in which they will visualize the need for these technologies and the case studies will give them a clear picture of the real industry problems. 2. This challenge makes the students aware of the Cobots and their importance in manufacturing. Also, AR is important in the training and inspection. 3. The topics such as cobots and IIOT real-time dashboards are aligned with this specific challenge.
	Day 15			Change Management and Its theories	0:17:57		
	Day 16			Strategies, and Role of Leadership in Digital Transformation	0:17:49		
	Day 17			Implementation Challenges, Organization Readiness, and Roadmap	0:20:04		
6	Day 18	Key Uses of Smart Manufacturing	AR for maintenance and training Predictive maintenance Virtual Training Cobots in manufacturing IIoT – Real Time dashboards and alerts Digital Twin	Predictive maintenance, AR, and, Virtual Training	0:18:15	Create a working KPI dashboard on MS Excel with the production data of any industry of choice. The dashboard should show all the analyses required by the manufacturing engineer to arrive at a logical conclusion. Take industrial case studies for the production data.	The KPIs in the industry and the IIOT dashboard which indicate this will be clearly understood by the students with practical case studies.
	Day 19			Cobots in Manufacturing, IoT Dashboards, and Digital Twin	0:30:09		

Unit - 3:

Week #	Day#	Title	Table of Contents	Video Title to	Video Duration	Unit Assessment	Outcomes
7	Day 20	Implementing Industry 4.0 for Smart Manufacturing	Typical Industrial set-up Implementing Industry 4.0 Industry wise pain points and challenges Key Performance Indicators in Industries	Industry Setup and Industry 4.0 Implementation	0:20:00	Download 3 case studies and prepare a detailed study report by comparing them. The report should show different technologies adopted by the different industries and their significance. The industries can be compared with OEE and a logical conclusion can be reached.	The case studies in this week's topics will give the student a clear idea about the connected manufacturing in the syllabus.
	Day 21				0:20:00		
	Day 22				0:20:00		
	Day 23				0:30:00		
8	Day 24	Smart Factories Usecases and Examples	Connected Manufacturing solutions: Use cases & Examples (5) Connected Supply chain: Use cases & Examples (2) Manufacturing Analytics: Concepts, examples & Use cases (3)	Manufacturing Solutions, Supply chain and Analytics	0:30:00	1. Download 3 relevant case studies on predictive maintenance. 2. Compare the average life cycle of the product and assess how the predictive maintenance has affected this life cycle.	The challenges are aligned with the concept of digital twins and how it helps in the predictive maintenance of the product.
	Day 25				0:30:00		
	Day 26				0:30:00		
	Day 27				0:30:00		
	Day 28				0:30:00		
	Day 29				0:30:00		

Unit - 4:

Week #	Day#	Title	Table of Contents	Video Title to Watch	Video Duration	Unit Assessment	Outcomes
9	Day 30	Industry 4.0 Impact on Environment and Sustainability	Environmental Management in Industry 4.0 Technologies for Environmental Management with I4.0 Challenges in implementing I4.0 for Environment & Sustainability	Environmental Management and Challenges in its Implementation	0:30:00	1. List the 7 wastes in Manufacturing 2. Recommend Industry 4.0 technologies to reduce/eliminate these 7 wastes (one technology for one type of waste) 3. Market research for the cost of technology and who can provide it within India 4. Prepare a report with ROI for each waste. For ROI estimation considers company XYZ losing 10 lakh/year on each type of waste (**Key Highlights (5 pointers)** Introduction to 7 wastes Market research for technologies ROI report preparation **Deliverables** A complete report with ROI details)	The core industry 4.0 components in the syllabus are being identified as the practical solutions for the 7 wastes in manufacturing. The students also learn about the 7 wastes in manufacturing which has been a relevant problem in the manufacturing industry for a very long time. The market research will give them better ideas of Indian companies that have implemented I4.0 technologies. The ROI calculation is directly related to the syllabus and it will give the analytical concept of I4.0 technologies to the students.
10	Day 31	Digital Twin	What is Digital Twin and How do they work? Role of Digital Twin in Smart Manufacturing	Introduction to Digital Twin, Digital Twins on IoT, and its Role in Smart Maufacturing	0:35:00		

	Day 32		Digital Twins Built on IoT Platform Digital Twins Platforms Digital Twins Implementation Digital Twins and Automotive Industry Future Trends	Implementation of Digital Twins, Digital Twins Platforms and Future Trends	0:35:00		

Unit - 5:

Week	Day#	Title	Table of Contents	Video Title to Watch	Video Duration	Unit Assesment	Outcomes
11	Day 33	Smart Machine	Introduction to Smart Machine Evolution of Smart Machine Building Blocks of Smart Machine Sensors and Signal Processing Controllers in smart Machines Smart Machine and Future Technology	Introduction and Evolution of Smart Machines	0:35:00	A project on creating Key Performance Indicator (KPI) dashboard for an Automotive Manufacturing company (Part of Industry 4.0 implementation KPI Dashboard is essential part of Industry 4.0 characteristic: Vertical Integration Different KPIs and Parameters that are essential in factories Calculation of KPIs and monitoring of parameters with sample production data KPIs from various functions – production, maintenance, quality & safety Use of MS Excel and IoT tools to prepare dashboards)	The syllabus topics such as KPI and IIOT are directly aligned with this project. The live dashboard creation from the live sensor data will allow students to replicate industry dashboards and will give them the necessary exposure to the KPIs and their various functions.
	Day 35			Controllers in Smart Machines and Future Technology	0:35:00		
12	Day 35	Digital Industry Transformation.	Product Life Cycle Management Material Requirement Planningonufacturing Process Management Manufacturing Execution System Enterprise Resource Planning	Product Life Cycle Management and Material Requirement Planning	0:35:00		
	Day 36			Manufacturing Process Management and Enterprise Resource Planning	0:35:00		

SB8012 POWERING IOT USING ARDUINO/ RASPBERRY PI L T P C
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Mandatory Components required in the Proposal

In response to the EOI we hereby intend to submit a proposal for onboarding us as a training partner of TNSDC under the Naan Mudhalvan program

Course Title: POWERING IOT USING ARDUINO/ RASPBERRY PI L T P C
1 0 2 2

Course Description: The Internet of Things is transforming our physical world into a Technology reliant and dynamic system of Connected devices on an unprecedent scale. The Internet of Things (IoT) is now omni present. Its significantly assists in collection of data, network and analyze such information received to provide real time information for societal benefits The course will focus on important IoT topics, which includes industrial standards, sensor/actuator/data devices, hardware, software, security, system design and performance analysis techniques.

Course Objectives: To impart the fundamental knowledge about Hardware and Software platforms for design and development IOT application

- Hardware: Prototyping board block diagram, microcontroller programming basics, simple sensors, sensor interfacing with prototyping board and, data acquisition and sensor calibration
- Software: Cloud platform for IOT development, IOT protocols, Embedded system Programming tool, Dashboard design for IOT webpage
  - To educate the students about a simple IOT application and verify its real-time performance by integrating the hardware and software components with LIVE results and interactive GUI.
  - To enable the students to design an IOT based monitoring & control system using a prototyping board, temperature sensor, LED, Buzzer, Stepper Motor, Embedded C / Python based code development, opensource IOT cloud-based dashboard design.
  - To enhance the skill of the students by giving them challenging projects and by providing them guidance through interactive LMS platform.

Course Outcomes: After the successful completion of this course, the students will be able to

1. Apply effectively the various enabling technologies like Embedded Systems including Embedded C for design of End device using ESP32 and network infrastructure protocols.
2. End design using Micro python and RPi PICO as well as Edge node design using Single Board Computer like Raspberry Pi and its integration with IoT infrastructure.
3. Select and design suitable communication technologies like WPAN, WLAN, LPWAN to meet the requirements of End and Edge node connectivity.
4. Apply various IoT Specific application protocols like CoAP, MQTT and Web Sockets to satisfy the constraint nature of nodes and various resources in IoT System
5. Integration of Edge and Cloud computing infrastructure with IoT End devices and deployment of closed loop IoT system from Sensing to Reacting (Actuation).
6. Design and build IoT system for a few interesting Use cases like Smart Water , Smart Energy, Smart waste management in the context of Smart City.

Various potential use cases(UC):

UC1 – Smart Farming: The student can develop the smart farming system, they can develop the automation systems in the farming processes. They will be able to develop, monitor, and control the processes of farming using the Internet of things, they can handle the use cases like smart irrigation systems, drone fertilization, and agricultural robots and monitor the soil using sensors like humidity, temperature, PH level, and fertility.

UC2 – Smart Industry: Industrial automation is possible only by IoT. So students who are well versed in IoT can develop automated systems in the Tech-industries. For instance, they can create a pick-and-place robotic arm, they can develop a safety monitor system in industries, and they can either develop a machine-to-machine communication in the industry.

UC3 – Smart Health: The student can develop a health monitor system, they can monitor the patient health with the help of health care sensors like EMG sensors, ECG, a body temperature monitor, and breathing monitor sensors. They can monitor the patient using the digital twinning mechanism that is created using the sensors incorporated system for the human body. There by jobs in Healthcare Segment.

UC4 - Smart City: The student can develop the use cases of a smart city like traffic monitor systems, garbage collectors, and monitor systems and can either create a simulation of the auto-driven vehicle using IoT simulators.

UC5 – Smart Home: The student will be able to form a network of household appliances. They can develop a home automation system where the household appliances can communicate with each other using wireless communication like Wi-Fi or Bluetooth. They can automate the garage door, smart fridge, smart AC, smart washing machine, and a voice control echo system. They will be able to identify the suitable IoT protocol for each use case.

Prerequisites: Basic Knowledge in Analog and Digital Electronics, C and Python Programming (Entry-level) *For those , not meeting the pre-requisite, a six hours bridge course will be conducted*

Course Hours and Mode of Delivery:

The Total course is for 45 hours in **Hybrid Format**

15 hours : Virtual Instructor Led Training

15 hours Virtual Labs based practical training

15 Hours of In person training using Arduino (ESP32) / Raspberry pi devices.

Course Deliver Plan:

SNo	Sessions	Mode of Delivery	Resources required
1	S1, S2,S3,S4,S8, S9,S10,S12,S14,S16, S20,S25,S28,S29,S30	Hybrid (15 Sessions)	Any One Hybrid Training Platform and a laptop installed with Arduino IDE , Cisco Packet Tracer and one set of hardware resources
2	S5,S6,S7,S11,S13 S15,S18,S19	In Person (8 Sessions	ESP 32 HW Kits
3	S17	In person (1 Session)	RPi PICO HW Kits
4	S21, S22, S23	In Person (3 Sessions)	RPi HW Kit with Accessories
5	S24, S26	In Person (2 Sessions)	ESP32 and RPi HW Kits
6	S27	Hybrid Mode (1 Sessions)	Cisco Packet Tracer

Training Standards:

Global Standards/Industry Standards: This curated course in of International Standard

Accreditation Authority: The course is certified by SkillsDA and Nasscom Future Skills

NOS Alignment: This is course is aligned to NOS/SSC N 8113; SSC/N 8120; SSC N 8210; SSC N 8213

Is Course design supported/endorsed by Industry players: Yes

If so Pls list the industries: defense, Healthcare, Automation, Drone

Course Curriculum

Powering Internet of Things using Arduino and Raspberry Pi

Session No	Topics	Theory / Practical	Course Outcome	Resources required
S-1	Introduction to Industrial Internet of Things	Theory	CO1	Hybrid mode training platform
S-2	Enabling Technologies of IoT - a detailed view	Theory	CO1	Hybrid mode training platform
S-3	Wireless Sensor Networks – Role of BLE Mesh and Wi-Fi Mesh in IoT	Theory and Demos	CO3	Hybrid mode training platform

S-4	Role of Cellular LPWAN (NB-IoT) and Non-Cellular LPWAN (LoRa, LoRaWAN) in IoT	Theory and Demos	CO3	Hybrid mode training platform
S-5	Embedded System design using MCU – ESP32- Usage of GPIO , Analogue Sensors and UART – Arduino Platform	Practical	CO1	ESP32 based IoT HW kit
S-6	Design of IoT End node using MCU – ESP32 and Arduino Platform	Practical	CO1	ESP32 based IoT HW kit
S-7	Integration of IoT End Node (ESP32 based) with ThingSpeak Cloud and deployment of closed loop end-to-end IoT application	Practical	CO5	ESP32 based IoT HW kit
S-8	Things in IoT and Identification (AIOTI) and Industrial IoT Reference Architecture	Theory	CO1	Hybrid training platform
S-9	IoT Enabling Technologies – Infrastructure, IP Addressing, Network Protocols	Theory and demos	CO1	Hybrid training platform
S-10	IoT Enabling Technologies - Data Connectivity Protocols - MQTT	Theory and demos	CO4	Hybrid training platform
S-11	Implementation of MQTT protocol using ESP32 as MQTT Client and Free on line MQTT broker	Practical	CO4	ESP32 HW Kit
S-12	IoT Enabling Technologies - Data Connectivity Protocols - CoAP	Theory and demos	CO4	Hybrid training platform
S-13	Implementation of CoAP protocol using ESP32 as CoAP Client and Server	Practical	CO4	ESP32 HW Kit
S-14	IoT Enabling Technologies - Data Connectivity Protocols - WebSockets	Theory and demos	CO4	Hybrid training platform
S-15	Implementation of WebSockets using ESP32 as WebSocket Server and browser extension as a WebSocket Client	Practical	CO4	ESP32 HW Kit
S-16	Introduction to RPi PICO – An ARM Cortex M series MCU based device as an IoT End Node	Theory and demos	CO2	Hybrid training platform

S-17	GPIO and Analogue Sensor Interface to RPi PICO using Arduino platform	Practical	CO2	RPi PICO HW Kit
S-18	Introduction to MicroPython and Embedded Application using MicroPython	Practical	CO2	ESP32 / RPi PICO Kits
S-19	IoT End Node design with ESP32 / RPi PICO and MicroPython for any one Industrial / Smart City Use case	Practical	CO1, CO2	ESP32 / RPi PICO Kits
S-20	Raspberry Pi – HW and Software Platform- Recap and detailed discussion towards application of RPi as End / Edge Device	Theory and Demo	CO2	Hybrid Training Platform
S-21	Interfacing of Analogue sensors to RPi using External ADC like MCP3008 and accumulation and display of sensor values in local web server	Practical	CO2	RPi HW Kits
S-22	Introduction to IFTTT and application of IFTTT Services for IoT Applications	Practical	CO4	ESP32 / RPi HW Kits
S-23	Video streaming and face recognition using ESP32 CAM / RPi with CAM	Practical	CO5	ESP32 / RPi Kits with CAM
S-24	Integration of ESP32 as End Device with RPi as Edge Computing Device integrated with Public Cloud - IIoT Real-time Use Case.	Practical	CO5	ESP32 plus RPi HW Kits / Cisco IoT Packet Tracer
S-25	Introduction to Node Red and Design of IoT workflow using Node Red Dash Board.	Theory and Demo	CO5	Hybrid training Platform
S-26	IoT Application using Raspberry Pi as Edge device with Node RED and MQTT Broker, NodeMCU / ESP32 as a End Device	Practical	CO5	ESP32 plus RPi HW Kits / Cisco IoT Packet Tracer
S-27	IoT based Smart Home Simulation using Cisco Packet Tracer	Practical	CO6	Hybrid training Platform and Cisco Packet tracer

S-28	IoT Data Analytics and Visualization - Implementation with IIoT and Industrial Real Time use Cases.	Demo	CO6	Hybrid training Platform
S-29	IIoT - Design and Deployment - Smart Energy Management System / Smart Water Management System integrated with Smart Cities of India - GIFT-City Model.	Demo	CO6	Hybrid training Platform
S-30	IoT use cases – Discussions and Conclusion	Theory and Demo	CO6	Hybrid training Platform

SNo	**Course Outcome**	**No of Theory and Demo Sessions**	**No of Practical Sessions**
1	**CO1**	**4**	**2**
2	**CO2**	**2**	**4**
3	**CO3**	**2**	**(integrated with 6 practical sessions related with end and edge nodes and cloud)**
4	**CO4**	**3**	**4**
5	**CO5**	**1**	**4**
6	**CO6**	**3**	**1**
Total		**15 (each 1 hour)**	**15 (each 2 hours)**

Mandatory Project work

One capstone project needs to be completed by students who will be grouped into a team of 3 members. Team has to get approval for the theme and concept before proceeding to carry out the project. Each team will be guided and mentored by experts

Students will be trained to align with job roles and industry requirements and it will be an a comprehensive hands on project work.

STUDENTS CAN CHOOSE ANY ONE USE CASE IN THE LIST AND BASED ON THE SELECTED USE CASE, THEY CAN DESIGN, BUILD AND DEPLOY CAPSTONEPROJECT WHICH COVERS ALL THE SIX COURSE OUTCOMES.

List of Software Students are exposed to

- **Tinker CAD**
- **Cisco Packet Tracer**
- **Postman**
- **Thingspeak**
- **Adafruit**
- **Ifft**

Duration of availability of Licensed Software to Students

- Will be available to the students for the full year

List of Hardware Students are exposed to

- **Esp 32**
- **Arduino Uno**
- **Raspberry pi**
- **Dht11, Potentiometer, LED**

List of consumables that will be given to per student

- **Workbooks**
- **Tutorials via LMS**
- **Assessment sheets**
- **Pen**

Student Assessment Plan :

MCQs on immersive learning on the Internet of Things, Embedded programming, Wireless Sensor Networks, LPWAN, Various Enabling Techniques, IoT Analytics, IoT End and Edge Node design. Edge and Cloud Computing, various use cases.

• Lab Assessments - Group Activities

- Working knowledge in IOT components and devices

• CAPSTONE Project to be carried out by the group and a Panel of Industry people will evaluate and review Project demonstrations.

S No	Nature of Assessment	No. of Assessments and plan	Rubrics	Marks allotted
1	Continuous Assessment Theory (CAT) Mid term 1,2 and 3rd before evaluation	3 MCQs - each 10 marks MCQ 1 – CO1 and CO2 MCQ2 – CO3 and C04 MCQ – CO5 and CO6	For each test there will be 20 MCQs – 30 Minutes duration – Total will be converted to 10 marks. (Correct answers will carry 1 marks, wrong answers will carry negative marks - 0.25 marks).	30
2	Continuous Assessment Lab (CAL)	5 Lab Assessments – Each10 Marks	Out of 10 marks – hardware design – 3 marks, Software design - 3 Marks , integration and testing – 2 marks demonstrating the output – 2 marks	50
CAL1	Lab Assessment 1 End node design using ESP 32 with appropriate sensors (**PIR senor, IR sensor, Ultrasonic sensor etc**., and actuators (Hardware :**Relay 5v ; 8 channel**. ESP32, IDE: Arduino, Embedded C Program using Arduino based programming constructs, WPAN-BLE and WLAN-Wi-Fi) [5] [CO1, CO3]			
CAL2	Lab Assessment 2: Design and Implementation of IoT Specific application protocols like MQTT / CoAP/ Websockets using ESP 32 as MCU for any one interesting IoT application(**Using stepper motor, MP3008 ADC module, Analog Senors**) [5] [CO4]			
CAL3	Lab Assessment 3: End node design using RPi PICO with appropriate sensors and actuators (Hardware : RPi PICO, IDE: Thonny Python Editor/ Arduino IDE, Embedded C Program using Arduino based programming constructs or Micro Python using Thonny Python Editor, WLAN-Wi-Fi) [5] [CO2, CO3]			
CAL4	Lab Assessment 4: Integration of End node using ESP 32 / RPi PICO with public cloud like FireBase, ThingSpeak or Ubidots ,(**using LoRa WAN)** data acquisition and IoT analytics using the data **controlling the appliances through the cloud based on the data acquired**. [CO5]			
CAL5	Lab Assessment 5: Design and deployment of IoT Application using ESP32 as a End Device and Raspberry Pi as Edge device with MQTT Broker and Node RED for data connectivity and Visualization. [COVERING ALL COS]			

3	Capstone project	One capstone project. maximum 3 students per team. Team has to get approval for the theme and concept before proceeding to carry out the project	Design- 3 Marks, Implementation – 4 Marks- Demo – 3 Marks, Presentation – 5 Marks, Viva – 5 Marks	20
	Total			**100**

Mid term /Unit Assessment 1

Assessment by way of Knowledge Check for every module .

Mid term /Unit Assessment 2

Assessment by way of practical test to check if the student can demonstrate the concepts learned.

Assessment 3 before Evaluation/Final Exam

Combination of 1st and 2nd assessment topics and preparation for final evaluation

Student Support Systems

If students are not following the course/not submitting assignments : *A special session will be conducted in weekends in hybrid method to discuss with the students and motivate them to complete assignments .*

If students fail in the assessment : *The reason for the failure will be assessed and correction will be done based on the out put and they will be provided another opportunity to get thro' the assessment.*

Doubts clearing platform: *This will be done every weekend till the completion of the course , assessment and final exam*.

Excellently performing students may be groomed further by giving enhanced training on higher level skillsets. The students may be given greater real-world challenges (typical industry scenario) and given star ratings based on their performance.

SB8013 AUGMENTED REALITY & VIRTUAL REALITY DEVELOPMENT L T P C

1 0 2 2

In response to the the Expression of Interest (EoI) invitation by Tamil Nadu Skill Development Corporation , the receipt of which is hereby duly acknowledged, we, the undersigned intend to submit the following proposal in response to the EoI for selection of Skill Training provider for Naan Mudhalvan Program of Government of TamilNadu

Course Topic: Augmented Reality & Virtual Reality Development

Target Group	**Engineering students –5th Semester (CSC, IT, EEE, ECE)**		
Subject	AR VR Development specific to CS, IT, EEE, ECE	**Total duration of the training in Hours**	45 hours (2 credits)
Theory Class Training in Hrs	15 hours (1 credit)	**Practical class Training in Hrs**	30 hours (1 credit)
Theory class focus area	Basic introduction, 3D design, metaverse, NFT, Block chain, business cases, use models	**Practical class focus area**	AR VR development for CS & other departments
Total credits	2 credits	**Type of training**	Hybrid

About the training Program:

Students will learn the fundamentals of AR & VR and introduction to application development through unity and other software.

Training Objective:

1. Introduce students to the concept of AR,VR, digital twins and Metaverse
2. Familiarise students with the HW and SW used in the field of AR & VR
3. Develop an understanding of the structure and architecture involved in the AR VR & metaverse application development
4. Develop AR VR application specific to their engineering field

Unit – I Fundamentals of AR VR 3

Fundamental AR VR concepts and characteristics, Nature of virtuality, introduced to AR VR hardware and software, AR VR applications across different industries, Introduction to Metaverse, Digital twin, Web3.0, NFT, Blockchain & Crypto currencies.

Lab component: 6

- Experience VR AR MR and its production tools
- Introduction to Unity

Outcome:

- Install and configure Unity software
- Differentiate between various realities (AR, VR, MR) and use the right terminology associated to present concepts and solutions

Unit – II Interactive Media Development 3

Taxonomy of Interactive Applications - immersive nature of AR VR technology - creative storytelling - gaming industry applications - concept for game - building a prototype – Consider Graphic styles and optimisation - communication and collaboration – Digital distribution – google play – iOS Store – Mac store.

Lab component: 6

- Create your first 3D prototype of the AR/VR experience

Outcome: Create design journey documents for developing AR VR experiences

Unit – III Fundamentals for Realtime scripting (c#) **3**

Introduction to Variables, Conditions, Loops, Patterns, - Scope of variables – OOPS in Realtime environments – Setting IDE – Scripting vs Programming – Enumeration – Memory management – Program states – Handing exceptions – Device considerations – Input systems – Hardware and Haptics feedback

Lab component: 6

- Learning Realtime programming (c#)

Outcome: Development of software code (C#) to optimise for Realtime programming pattern for AR VR Experiences

Unit – IV Level Design for AR VR using Unity 3

Basic concepts of Level designing, Level mapping – Level creation techniques – Grey boxing techniques, Focus on the layout and composition – Prioritize assets based on block out – Accessing Unity asset store – importing FBX assets – Building a level for VR/AR, Level Optimization

Lab component: 6

- Level Creation using Unity

Outcome: Develop Level design within considerations of Unity Real-time rendering concepts

Unit – V Solution Design for AR VR 3

Design process – mood board – design specification document – technical project management – AR architecture & frameworks – ARKit – Arcore – Vuforia – VR architecture & frameworks – HTC – Windows Mixed reality – Oculus – XR and definition – XR over cloud – Emerging trends in AR VR MR

Lab component: 6

- Mini Project on the Selected AR or VR device

Outcome: Design, Develop & Deploy AR or VR application in devices after building design flow that reflects user experiences

Training Hours - 15 Hrs (Theory) + 30 Hrs (Practical) = 45 Hrs

Course Delivery Plan

Sl. No	Hourly Content Plan	Delivery Tools	Delivery Mode	Project/ Exercises	T/P
1	Fundamental AR VR concepts and characteristics, Nature of virtuality, Introduction to Metaverse	PowerPoint, Live Instructor Sessions	Online	Create a digital profile	T
2	Introduction to AR VR hardware and software, Hardware features, analogue, digital, haptics, and trackers systems	PowerPoint, Live Instructor Sessions	Online	Write about the haptics profile of mobile	T

3	AR VR applications across different industries, Digital twin, Web3.0, NFT, Blockchain & Crypto	PowerPoint, Live Instructor Sessions	Online	Write a report of AR VR in day-to-day usage	T
4	Installing Unity	Recorded video with instructor voice over	Online	Setup Unity IDE and other dependency	P
5	Taxonomy of Interactive Applications - immersive nature of AR VR technology	PowerPoint, Live Instructor Sessions	Online	Report on Immersion vs interactivity	T
6	creative storytelling - gaming industry applications - concept for game - building a prototype	PowerPoint, Live Instructor Sessions	Online	Story Map and User Journey	T
7	Consider Graphic styles and optimisation - communication and collaboration – Digital distribution – google play – iOS Store – Mac store.	PowerPoint, Live Instructor Sessions	Online	Choose and define a art style, with a relevant distribution platform	T
8	Create your first 3D level in Unity	Recorded Video/ PowerPoint	Online	Install blender and create a primitive shape	P
9	Create your first 3D level in Unity	Recorded Video/ PowerPoint	Online	Create static meshes and detail meshes	P
10	Create your first 3D level in Unity	Recorded Video/ PowerPoint	Online	Create Materials and optimise textures	P
11	Create your first 3D level in Unity	Recorded Video/ PowerPoint	Online	Enable and build colliders and other physics	P
12	Create your first 3D level in Unity	Recorded Video/ PowerPoint	Online	Animate objects and setup state machines	P
13	Create your first 3D level in Unity	Recorded Video/ PowerPoint	Online	Bake and build lighting	P

14	Introduction to Variables, Conditions, Loops, Patterns, - Scope of variables – OOPS in Realtime environments	PowerPoint, Live Instructor Sessions	Online	Simple programs for numerical operations	T
15	Program states – Device considerations – Input systems – Hardware and Haptics feedback	PowerPoint, Live Instructor Sessions	Online	Flow chart expressing input and feedback systems	T
16	Setting IDE – Scripting vs Programming – Enumeration – Memory management –Handing exceptions – Device considerations	PowerPoint, Live Instructor Sessions	Online	Data structures & Programming patterns	T
17	C# Unity functions and variables, Addition of two numbers and printing a series of numbers	PowerPoint, Live Instructor Sessions	Online	Lab programs on numerical operations	P
18	String operations in C# and finding greatest numbers	PowerPoint, Live Instructor Sessions	Online	Lab programs on string operations	P
19	Controlled Loops, enumerations & coroutines in C#	PowerPoint, Live Instructor Sessions	Online	Lab programs on program states	P
20	Translate, rotate, and scale objects using code	PowerPoint, Live Instructor Sessions	Online	Lab programs on vector operations	P
21	Awake, Start, Update, FixedUpdate and LateUpdate	PowerPoint, Live Instructor Sessions	Online	Lab program about coroutines	P
22	Vehicle moving and input handling	PowerPoint, Live Instructor Sessions	Online	Lab programs on input operations	P
23	Basic concepts of Level designing – Level sketching, Level creation techniques.	PowerPoint, Live Instructor Sessions	Online	Select and define a 3D model layers	T

24	Level design using Greybox – Focus on the layout and composition – Prioritize assets based on block out.	PowerPoint, Live Instructor Sessions	Online	Find examples of unwrapping and list them	T
25	Basic Animation using Mixmo, Building Scene for VR/AR, Optimization	PowerPoint, Live Instructor Sessions	Online	Explain zoetrope and its function	T
26	3D Asset importation using Unity Asset store	PowerPoint, Live Instructor Sessions	Online	Create a simple 3D digital identy	P
27	Design process – mood board – design specification document – technical project management	PowerPoint, Live Instructor Sessions	Online	Create a project plan for the given design document	T
28	AR architecture & frameworks – ARKit – Arcore – Vuforia –	PowerPoint, Live Instructor Sessions	Online	Compare various AR types and submit a report	T
29	VR architecture & frameworks – HTC – Windows Mixed reality – Oculus – XR and definition – XR over cloud – Emerging trends in AR VR MR	PowerPoint, Live Instructor Sessions	Online	List and build a list of new VR headsets in market	T
30	3D asset importation for AR using Unity asset store	PowerPoint, Live Instructor Sessions	Online	Build a simple AR space model through textures and Image markers	P
31	Experience with AR VR	PowerPoint, Live Instructor Sessions	Onsite	Experience VR Horizon line, cyber sickness	P
32	Experience with AR VR	PowerPoint, Live Instructor Sessions	Onsite	Experience space to comfort ratio	P
33	3D VR Asset from Unity asset store & create an environment	PowerPoint, Live Instructor Sessions	Onsite	Create your 3D asset with Kit bashing	P

34	3D Integration with Unity Engine	PowerPoint, Live Instructor Sessions	Onsite	Create your 3D Project and create your level	P
35	AR Project – Vuforia Integration	PowerPoint, Live Instructor Sessions	Onsite	Setup Vuforia and link developer setup	P
36	AR Project – Vuforia Integration	PowerPoint, Live Instructor Sessions	Onsite	Create markers and build & test on device	P
37	VR Project Setup – Oculus/Carboard Integration	PowerPoint, Live Instructor Sessions	Onsite	Install VR Framework and level optimisation	P
38	VR Project Setup – Oculus/Carboard Integration	PowerPoint, Live Instructor Sessions	Onsite	Complete Manager and Interaction script for deployment.	P
39	VR Mini Project (scope mentioned in the next section)	Selected Device	Onsite		P
40	VR Mini Project (scope mentioned in the next section)	Selected Device	Onsite		P
41	VR Mini Project (scope mentioned in the next section)	Selected Device	Onsite		P
42	VR Mini Project (scope mentioned in the next section)	Selected Device	Onsite		P
43	VR Mini Project	Selected Device	Onsite		P
44	VR Mini Project	Selected Device	Onsite		P
45	Photogrammetric Modelling	iPhone, PowerPoint, Agisoft	Onsite		P

COURSE OUTCOMES:

On successful completion of the course, students will be able to:
LO1: Create a 3D model in blender of any given object and apply texturing and animation.

LO 2: Convert the 3D asset in blender into a ready-to-use model for unity.

LO 3 : Apply functionalities to the model such as movement, rotation, etc., by importing appropriate AR/VR plugins and setup any lighting if required in Unity.

LO4 : Create AR/VR application for visualizing through any AR/VR devices.

STUDENTS ASSESSMENT :

Model a simple conference room with furniture, electrical devices (Light, Fan,Switches), etc, and develop a marker-less based Augmented Reality and/or Virtual Reality application.

There will one assignment & MCQ planned at the end of each unit and one final project which will be used for the final exam marks.

Evaluation Plan & Grading Criteria:

Continuous Learning Assignment :

Unit	**Unit -I**	**Unit-II**	**Unit – III**	**Unit IV**	**Unit V**	**Total**
MCQ	10 Questions	10 Questions	10 Questions	10 Questions	10 Questions	
Points	10	10	10	10	10	50
Assignment	1. Report on AR/VR HW. 2. Install Unity & confugure	Create a design journey document	Convert the given program to realtime Program	Create a level with all required optimizations	Submit your AR Marker for AR application	
Points	10	10	10	10	10	50
					Total	100

Summative or Final Mandatory Project at the end of the course (Unit 5):

Criteria	**Idea**	**Technology structure**	**Mechanics**	**Code optimization**	**Final Build**	**Total**
Points	20	20	20	20	20	100

Mandatory Project details:

Identify a content from your field of study and convert the learning content into an interactive VR experience in your field. Follow the steps below to complete the pipeline requirements.

- The content plan, Experience design, technical specifications, Test cases are to be defined before start of Production

- Choose Target devices and the right VR framework and explain the procedure to be followed
- Create any assets required and integrate them in any VR tool of your choice
- Build the experience using programming concepts for handling inputs
- Create a test group and record findings for publishing the final report

Mode of Delivery: Hybrid

Hybrid of 45 hours with:

- 22.5 hours of physical practical/lab classes
- 15 hours of on-line theory classes
- 7.5 hours of on-line lab classes

Execution: A total of 5 weeks

- 1 week of on-line training
- 4 weeks of Physical training across 4 clusters with 25 colleges per cluster
    - Each college will get 5 days of physical training with 4.5 hrs per day for a total of 22.5 hours.
    - Similar training will be provided to 25 colleges in parallel.
- A total of 5 weeks will be required to finish the training
    - Each cluster of 25 colleges will get 1 week of on-line & 1 week of physical training.

Hardware & Software to be used:

- Hardware/Devices that will be demonstrated to the students: Oculus Quest VR, Google VR, Smartphone AR, and Smartphone VR
- Software Licenses that will be taught/used: Blender based tools/plugins, GIMP/Photoshop, Unity with c#, Visual Studio, Vuforia, Oculus SDKS
- All software chosen are open source or free for students. It would be available for students even after the course
- Smartphone hardware available with the students can be used to develop and AR VR applications even after the course. Specialized VR hardware like Oculus Quest can be accessed at 50 AR VR locations in TN and the college can also invest.

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COURSE OBJECTIVE

The objective of this course is to provide a view of design principles to present ideas, information, products, and services on websites and how to apply programming principles to the construction of website and effective use of available resources for website projects.

PRE-REQUISITE COURSES:

Pre-requisite Knowledge	Courses Available on Springboard
HTML5	HTML 5
Javascript	Javascript
Typescript	Typescript

UNIT-I ANGULAR **36**

Getting Started with Angular - Angular Development Environment Setup - Creating Components and Modules – Templates – Directives - Data Binding – Pipes - Nested Components – Forms - Services – Routing - Angular Capstone Projects [Hands-on Exercises for Web Application Development Using Capstone Project]

UNIT-II NODE.JS AND EXPRESS. JS **12**

Node.js: Why and What Node.js - How to use Node.js - Create a web server in Node.js - Node Package Manager - Modular programming in Node.js - Restarting Node Application - File Operations. Express.js: Express Development Environment - defining a route - Handling Routes - Route and Query Parameters - How Middleware works - Chaining of Middleware's - Types of Middleware's - connecting to MongoDB with Mongoose - Validation Types and Defaults – Models - CRUD Operations - API Development - Why Session management – Cookies – Sessions - Why and What Security - Helmet Middleware - Using a Template Engine Middleware - Stylus CSS Pre-processor. [Hands-on Exercises to practice the topics using problem statements]

UNIT-III MONGO DB **12**

MongoDB: Introduction Module Overview- Document Database Overview- Understanding JSON- MongoDB Structure and Architecture- MongoDB Remote Management- Installing MongoDB on the local computer (Mac or Windows)- Introduction to MongoDB Cloud- Create MongoDB Atlas Cluster- GUI tools Overview- Install and Configure MongoDB Compass- Introduction to the MongoDB Shell- MongoDB Shell JavaScript Engine- MongoDB Shell JavaScript Syntax- Introduction to the MongoDB Data Types- Introduction to the CRUD Operations on documents- Create and Delete Databases and Collections- Introduction to MongoDB Queries.[Demos to practice the topics mentioned]

TOTAL: 60 PERIODS

SUGGESTED ACTIVITIES

CONTINUOUS / SELF-ASSESSMENT (MCQ)

Capstone Project - Develop an Ecommerce site or similar web applications with cross platform responsiveness. The application must possess search, sort, review, rating, ordering features and be connected with a database to be published across HTTP and HTTPS protocols.

SUGGESTED EVALUATION METHODS

Video Proctored Exam

Self-Assessment

COURSE OUTCOMES

On completion of the course, students will be able to,

CO1 : Develop component-based application using Angular Components.
CO2 : Create Angular forms and bind them with model data using data binding.
CO3 : Explain Node.js and identify when to use, create and run Node.js.
CO4 : Design schema using advanced queries.

REFERENCE

1 https://infyspringboard.onwingspan.com/web/en/app/toc/lex_20858515543254600000_shared/overview (Angular)

2 https://infyspringboard.onwingspan.com/en/app/toc/lex_32407835671946760000_shared/overview (Node.js & Express.js)

3 https://infyspringboard.onwingspan.com/en/app/toc/lex_auth_013177169294712832113_shared/overview (MongoDB)

Mode of Delivery	Online (Self-Learning)
Software Configuration to be arranged in Institution Premises	Node.js Typescript Angular CLI Visual studio code MongoDB
Hardware Configuration to be arranged in Instituion Premises	Windows 10, 16GB RAM
Course Evaluation	Online Assessment
Multiple Hybrid Branch of Students	Applicable for IT/CSE
Internship/Placement Opportunities	https://infytq.onwingspan.com/
NOS Alignment	Yes- Infosys Industry Standard
Train-the-Trainer	Faculty Enablement Program
Commercials	Free of Cost

SB8015	CYBERSECURITY	L	T	P	C
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COURSE OBJECTIVE

The objective of this course is to provide a view of data science, machine learning, basic implementation using Python and how machine learning is applied in various domains in the industry

UNIT-I NETWORKING AND WEB TECHNOLOGY 7

Network Components - Network Basics - Network Communication -Web Technologies TCPIP - Web Services

UNIT-II INTRODUCTION TO CYBER SECURITY 8

Recent Cyber Attacks - Cyber Security Concepts - Layers of Cyber Security - Introduction to Application Security - Secure Coding OWASP Top 10 - Coding Practices Secure Design – Closure [Practical demos and code on OWASP vulnerabilities and how to mitigate them]

UNIT-III FUNDAMENTALS OF INFORMATION SECURITY & FUNDAMENTALS OF CRYPTOGRAPHY 7

Why information security? - What is information security? - Data Security - Network security - Application Security – Closure. Why Cryptography? – Cryptography - Shared Key Cryptography – Illustration - Shared Key Cryptography - Public Key Cryptography – Illustration - Public Key Cryptography – Hashing -Digital Signature – Illustration - Digital Signature - Applications of cryptography – Conclusion [Algorithmic representation of cryptographic methods]

UNIT-IV THREAT MODELING & IDENTITY AND ACCESS MANAGEMENT 6

Basics of Threat Modeling - Learn Threat Modeling with a Use Case - Tool Walkthrough - MS Threat Modeling Tool – Assignment - Introduction to Identity and Access Management - What next

UNIT-V JAVA SE 11 PROGRAMMER II: SECURE CODING IN JAVA SE 11 APPLICATIONS 7

Course Overview – Managing Denial of Service – Securing Information – Managing Data Integrity – Accessibility and Extensibility – Securing Objects – Serialization and Deserialization Security – JCA and its Principles – Provider Architecture – Engine Class – Key Pair Generation – Signature Management – Unsecure to Secure Object – Course Summary. [Demos of Secure Coding in Java]

UNIT-VI SECURITY STANDARDS AND REGULATIONS 5

PCI DSS – ISMS -FIPS and NIST Special Publications – FISMA – GDPR – HIPAA – SOX - Conclusion

UNIT-VII IDENTITY GOVERNANCE AND ADMINISTRATION 5

Need for IGA & basics concepts - IGA Basic Concepts and On boarding - IGA Governance - Identity Administration in IGA - What next?

TOTAL: 45 PERIODS

SUGGESTED ACTIVITIES

CONTINUOUS / SELF-ASSESSMENT (MCQ)

CAPSTONE PROJECT

Activity 1 : Converge system configuration details listed below for a given machine

Firewall configuration (Policy Setup)

Network Configuration (IP address, DNS etc)

Activity 2 :

Evaluate the website vulnerabilities for a given webpage

Activity 3 : Implement security audit for an organization with the basic security requirements such as

- Firewall Policy Details
- Access Control Mechanism
- Router Configuration

SUGGESTED EVALUATION METHODS

- Video Proctored Exam
- Self-Assessment

COURSE OUTCOMES

On completion of the course, students will be able to:

CO1 : Demonstrate network components, DHCP, DNS Server and TCP/IP architecture
CO2 : Apply and validate the design of web applications by applying Threat modelling.
CO3 : Analyze some of the applications of these cryptographic primitives in cryptographic protocols and technologies.
CO4 : Apply Microsoft Threat Modeling Tool for creating threat models.
CO5 : Investigate how to secure sensitive objects, and secure serialization and deserialization in Java. You will describe JCA, including its architecture and the principles surrounding it
CO6: Demonstrate important Security Standards and Regulations like PCI DSS, ISMS, FIPS, NIST Special Publications, FISMA, GDPR, HIPAA and SOX.
CO7: Recognize Identity Governance and Administration (IGA); what problems IGA solutions solve; governance models like - roles, certifications, policies; and identity life cycle management.

REFERENCE

1 https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_0125451278416527367 1_shared/overview (Networking and Web Technology)

2 https://infyspringboard.onwingspan.com/web/en/app/toc/lex_3388902307073574000_shar ed/overview (Introduction to Cyber Security)

3 https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_0126391642460897284 2_shared/overview (Fundamentals of Information security)

4 https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_0126668847068037127 03_shared/overview (Fundamentals of Cryptography)

5 https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_0126088424780595203 07_shared/overview (Threat Modeling)

6 https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_0126568855293460482 98_shared/overview (Identity and Access Management)

7 https://infyspringboard.onwingspan.com/web/en/viewer/html/lex_auth_0135015917296926 7213125 (Java SE 11 Programmer II: Secure Coding in Java SE 11 Applications)

8 https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_0126235884826214402 865_shared/overview (Security Standards and Regulations)

9 https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_0126428637035806721 584_shared/overview (Identity Governance and Administration)

Mode of Delivery	Online (Self-Learning)
Course Evaluation	Online Assessment
Multiple Hybrid Branch of Students	Applicable for ECE/EEE/IT/CSE
Internship/Placement Opportunities	https://infytq.onwingspan.com/
NOS Alignment	Yes- Infosys Industry Standard
Train-the-Trainer	Faculty Enablement Program
Commercials	Free of Cost

SB8016 **Big Data Analytics** **L T P C**

1 0 2 2

Modules	Duration in Hours
Introduction to Big Data & Hadoop	45
Scala Essentials	
In Memory Computation for Big Data	
SQL Like Query Processing Engine for Big Data: Hive	
Real time Big Data Processing	

SB8017 **Cloud Essentials** **L T P C**

1 0 2 2

Modules	Duration in Hours
Linux	45
Cloud Computing Fundamentals	
Architecting Cloud Solutions	
Managing Cloud Solutions	
Migrating to Cloud	

Big Data Analytics | Objectives

After the completion of respective modules, learners will be able to:

Module	Outcomes	No. of hours of theory	No. of hours of labs
Introduction to Big Data & Hadoop	Identify the various types of data Store large amount of data into HDFS Process data using Hadoop Navigate through Hadoop Web UI Analyse various metrics using Hadoop Web UI Run various Hadoop Terminal Commands Ingest structured data into HDFS using Sqoop	2	4
Scala Essentials	Perform basic Scala operations Use control structures in Scala Create functions in Scala Use Collections framework in Scala Write basic programs using Scala Create Classes and objects using Scala Write programs using OOPs concepts	2	4

Big Data Analytics | Objectives

After the completion of respective modules, learners will be able to:

Module	Outcomes	No. of hours of theory	No. of hours of labs
In Memory Computation for Big Data	Differentiate between Disk-based and In-memory Processing Systems Use Spark in Different Deployment Modes Run Spark applications on Spark shell Configure Spark properties & view them in Web UI Perform data loading and saving through RDDs Write Spark applications using RDDs concepts Query structured data inside Spark programs using Spark SQL	3	6
SQL Like Query Processing Engine for Big Data: Hive	Write Hive Queries & Hive Scripts Execute Hive Queries on top of HDFS Create Dynamic and Static Partitions Create Buckets for Data Sampling Perform various Joins in Hive Perform ETL operations & data analytics using Hive Implement Partitioning, Bucketing, and Indexing in Hive Use various file formats in Hive	3	6
Real time Big Data Processing	Ingest unstructured data into HDFS using Flume Perform real-time data processing using Spark Work with various Kafka Command Line Tools Create data pipelines using Kafka	5	10

Cloud Essentials | Objectives

After the completion of respective modules, learners will be able to:

Module	Outcomes	No. of hours of theory	No. of hours of labs
Linux	Work with various Linux commands Manage and perform user administration Differentiate between IPV4 and IPV6 address	2	4
Cloud Computing Fundamentals	Explain the concept of Virtualization Define Cloud Computing Categorize different Cloud Computing service models Categorize different Cloud Computing deployment models Describe AWS Global Infrastructure Work with AWS CLI Identity and Access Management	2	4

Cloud Essentials | Objectives

After the completion of respective modules, learners will be able to:

Module	Outcomes	No. of hours of theory	No. of hours of labs
Architecting Cloud Solutions	Create EC2 compute instances Store data into S3 buckets Create a virtual private network Query data using various database services such as RDS Configure various AWS core services such as EC2, RDS, VPC, S3	4	8
Managing Cloud Solutions	Monitor various AWS resources using CloudWatch Perform load balancing and auto scaling Manage and optimize cloud cost Build resilient and robust cloud architectures	4	8
Migrating to Cloud	Gather information about various on-premise resources using application discovery Perform homogeneous and heterogeneous database migration to AWS cloud Migrate on-premise resources to AWS cloud Migrate application to AWS cloud	3	6

Evaluation Process

Assessment Methodology

- Learning = practical application of various tools covered in the course
- Course Assessment
  - Multiple Choice Questions
- Assessments are **auto graded**
- **Learning effectiveness** for any learner
  - Completion of all the course modules and assessments
- A short project will be provided to the students at the end of the course for assessment
  - Faculty in the college should guide the students locally to help them clarify their queries
  - Faculty also should assess the project & provide marks to Veranda for consolidation
  - Sample project (indicative to demonstrate the complexity) is shared as separate files for reference

MCQ based assessment help the learner s to clear their interviews

Continuous Evaluation

- Self-paced video consumption through LMS portal
- Hands-on practice through practical labs
- Graded assessments (MCQs) after every module of course content
- Module Assessment
  - Real-time scenario based MCQs
- Course-completion certification

Big Data Analytics – Evaluation Parameters

Sr. No.	Aspect of description	Extra aspect of description	Maximum marks
1	Data Identification	Identify whether the data is structured, semi-structured or unstructured	5
2	Data Ingestion	Ingesting Structured or unstructured data using Sqoop and Flume	6
3	Data pre-processing	Data cleaning and Data transformation	5
4	Data Store	Storing pre-processed data into HDFS	4
5	Data processing	Processing data to get meaningful insights using Spark and Kafka	5
Total			**25**

Sr. No.	Aspect of description	Extra aspect of description	Maximum marks
1	Linux	Implement Linux Commands to work with AWS CLI	5
2	Cloud Computing	Identify cloud service and deployment model	5
3	Cloud Solution Designing	Identify and configure various AWS services for a given requirement	5
4	Monitor cloud resources	Monitor AWS resources and design scalable solutions	5
5	Cost Optimization	Optimize the cloud solution cost	5
Total			**25**

LMS FEATURES:

- *Byte sized learning videos.*
- *Accessible through PC and mobile devices.*
- *Integrated MCQ assessments.*
- *Personal content library for additional readings*

Course| Questionnaire

Questions	Cloud Essentials	Big Data Analytics
MODE of Course	Online	Online
SECTOR	Information Technology	Information Technology
DEGREE	UG/PG	UG/PG
SPECIALIZATION (Engineering, Arts & Science, Polytechnic, ITI,	Engineering, Arts & Science, Polytechnic, ITI	Engineering, Arts & Science, Polytechnic, ITI
BRANCH	Any	Any
SEMESTER	7	5
DURATION in HOURS*	45	45
DESIGNED DURATION in WEEKS	15 weeks (1 Semester)	15 weeks (1 Semester)
COURSE MODULE	Linux, Cloud Computing Fundamentals, Architecting Cloud Solutions, Managing Cloud Solutions, Migrating to Cloud	Introduction to Big Data & Hadoop, Scala Essentials, In Memory Computation for Big Data, SQL Like Query Processing Engine for Big Data: Hive, Real time Big Data Processing

Course | Questionnaire– *Continued*

Questions	Cloud Essentials	Big Data Analytics
COURSE OUTCOME	Developing and implementing policies for the use of cloud services, managing requests for new technology, establishing a secure cloud environment, and ensuring appropriate availability of services	• This course provides an overview of approaches facilitating data analytics on huge datasets. • Different strategies are presented including sampling to make classical analytics tools amenable for big datasets. • Students will be exposed to various analytics tools such as Apache hive, apache flume, Kafka, MySQL
COURSE TYPE	Paid	Free
TOTAL NUMBER OF ENROLMENTS	6300	6400
TOTAL NUMBER OF COMPLETION	1061	1200
TOTAL NUMBER OF CERTIFIED	1061	1200
CERTIFICATION (Mention Global and Industrial recognition)	None	None
MODEL CERTIFICATION (Need to upload)	Shown in earlier slides	Shown in earlier slides
NOS Aligned (Yes/No)	No (applied for it)	No (applied for it)

Course | Questionnaire – *Continued*

Questions	Cloud Essentials	Big Data Analytics
Personalized student support system intervention plan if student not following the course.	Progress of each student can be tracked in the LMS. College faculty members can access this info from the LMS. VLS will train the college faculty members in the beginning for providing onsite support to the students. ● We will be creating online 1 doubt clearing sessions for faculties and the students can share the doubts with the faculties, which will be in turn cleared in these sessions ● We will provide pre recorded videos for frequently asked questions	Progress of each student can be tracked in the LMS. College faculty members can access this info from the LMS. VLS will train the college faculty members in the beginning for providing onsite support to the students. ● We will be creating online 1 doubt clearing sessions for faculties and the students can share the doubts with the faculties, which will be in turn cleared in these sessions ● We will provide pre recorded videos for frequently asked questions
Personalized student support system intervention plan if student fail in the final assessment.	VLS will train the college faculty members in the beginning for providing onsite support to the students. We provide unlimited retake option and student can also discuss the assessment related queries in their doubt clearing sessions	VLS will train the college faculty members in the beginning for providing onsite support to the students. We provide unlimited retake option and student can also discuss the assessment related queries in their doubt clearing sessions

Course | Questionnaire – *Continued*

Questions	Cloud Essentials	Big Data Analytics
Hardware Requirement	Laptop -- 16 GB RAM 250 HDD Minimum i5 8th gen X64 bit Internet connectivity – 100 Mbps and above	Laptop -- 16 GB RAM 250 HDD Minimum i5 8th gen X64 bit Internet connectivity – 100 Mbps and above
Additional Requirements	All students should activate individual cloud accounts (AWS, Azure or Google) using their credit cards. Veranda will add a session to the course to educate the students how to activate/deactivate the account.	
Personalized student support system intervention plan to clear doubts during the course.	Onsite faculty & Webinar	Onsite faculty & Webinar

Cloud Essentials - Project

Background: A start-up company wants to host its Python and React-based application (Backend: Python API and Frontend React) using AWS. But they are not familiar with the AWS cloud platform. They want to ensure that the application is secure, scalable, highly available, and cost-efficient. As a solutions architect, you have to design a proper solution to meet their below requirements.

Goal: To architect a solution that is secure, scalable, highly available, and cost-effective using AWS.

Requirements:

• They are concerned about the security of the application, so they have decided to isolate their network from the rest of the customers virtually. Set-up a secure virtual network where the only frontend of application is accessible by users and not the database

• Execute the React application code using AWS Elastic Beanstalk. Ensure that the source code of Web application is automatically picked, pushed to the master branch, and deployed on the servers

• Ensure all the UI images served to the frontend application code are provisioned via a secure storage unit

• There should be enough backups for both the Web and Database server, so if the set-up crashes, we can launch a new one from the disaster recovery backups

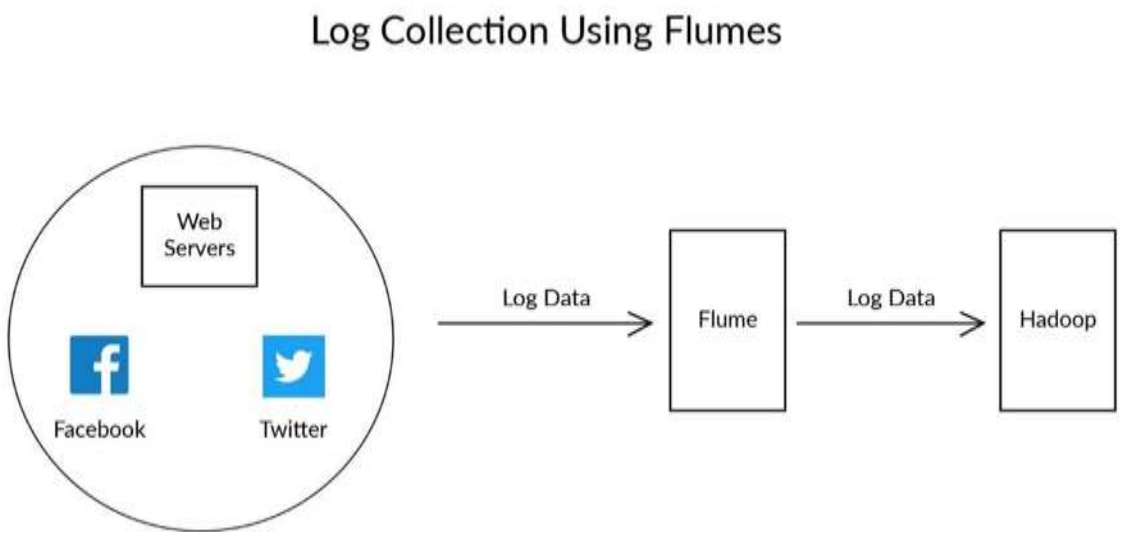
• They are uncertain about the traffic pattern that how low or high it can be, so they want the Web application to be running on at least two EC2 instances all time, and when there is a high load, they must burst up to four instances in total

• The Web application should be highly available, even if any VM fails to respond to queries, there should be a mechanism to switch the connection to another healthy VM automatically

• The Web application should also be cached globally, so users worldwide can access it with low latency

Problem Statement: Real-time Data Collection Imagine you are a Big Data Engineer, and you need to fetch logs from the web servers into your Hadoop Cluster for doing some analyses to generate some business insights.

The following figure illustrates a scenario where we need to ingest logs from sources like web servers, facebook, twitter, etc. into the Hadoop clusters and then use the ingested data as required.



As a Big Data Engineer, your task is to ingest the logs generated by the given LogGenerator.jar file into HDFS using the two Flume agents.

NOTE: 1. Configure the Flume agent 1 to consolidate the logs from the spoolDir source to an Avro sink. 2. Configure the Flume agent 2 to consolidate the logs

from the Avro source to an
HDFS sink