Jharkhand University of Technology
Ranchi, 834010

TENTATIVE SYLLABUS

For Diploma Program in
Electronics & Communication Engineering

(Effective from 2025-26)

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

(5th – SEMESTER)

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Course Code- **L:T:P**

Introduction:

Welcome to the curriculum for the Artificial Intelligence and Machine Learning (AI&ML) Specialisation. This specialisation course is taught in Bootcamp mode. Bootcamps are 12 weeks, intense learning sessions designed to prepare you for the practical world – ready for either industry or becoming an entrepreneur. You will be assisted through the course, with development-based assessments to enable progressive learning. In this course, you'll learn how to produce a computer- assisted solution when data is too complex for humans to find answers as they combine both data science and machine learning skills that are needed for today's job market.

Some common examples include; Amazon Alexa - converting spoken audio into language; Google Image Search – uses image recognition to return specific search results; Samsung Smart Fridges – uses data and machine learning to produce intuitions about your behavior. Leading to the successful completion of this bootcamp, you shall be equipped to either do an internship at an organization working in AI or do a project in AI. After the completion of your Diploma, you shall be ready to take up roles like Machine Learning Engineer, Data Scientist, Data Analyst, and more.

This course will teach you Fundamentals of AI, Python and Python libraries, data visualization, machine learning models, maths like linear algebra, data interpretation, deep learning, Version control system, cloud deployment and more. Details of the curriculum is presented in the sections below.

Pre-requisite

Before the start of this specialisation course, you would have completed the following courses;

In the 1st year of study, you would have studied Engineering Mathematics, Communication Skills, Computer Aided Engineering Graphics, Statistics & Analysis, Basic IT Skills, Fundamentals of Computer, Fundamentals of Electrical and Electronics Engineering, Project Management skills and Multimedia & Animation.

In the 2nd year of study, you would have studied Python Programming, Computer Hardware, Maintenance and Administration, Computer Networks, Database System Concepts and PL/SQL, Data Structures with Python, Operating System and Administration, Object oriented programming and Design with Java, Software Engineering principles and practices.

In this year of study, you shall be applying your previous years learning along with specialised field of study into projects and real-world applications.

Course outcome: A student should be able to

CO1	**Explain the concept of AI, its applications, constituents and challenges of ethics in AI.**
CO2	**Analyze and visualize any given dataset**
CO3	**Evaluate, optimize, build and test an AI model for a given requirement**
CO4	**Perform comparative analysis of methods or algorithms for a given requirement**
CO5	**Select the appropriate tools, production environment and deploy the model.**

Detailed course plan

Week	C O	P O	Days	1st session (9am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
1	1	1	1	1. AI based movie (Screening)			4	- AI influence in companies viz, Amazon, Microsoft, Google, IBM - Latest developments in AI domain - Google's DeepMind AI Just Taught Itself To Walk - YouTube - Introducing Amazon Go and the world's most advanced shopping technology - YouTube - IBM Watson - Understanding the evolution of AI and HMI (human machine interface) - Discussion on how AI will Impact of daily life, work life, work force, jobs, products and services – T	2		1
	1	1	2	Fundamentals of AI - What is artificial intelligence? - How AI works - Purpose of AI - Types of Artificial Intelligence - Goals of AI - Applications of AI	3		1	- Significance of data in AI - AI Software Development life cycle - Compare traditional software development with AI Software Development - Example – Game rules (Chess) Explore and prepare a report on all popular AI cloud services (ML & DL) offered by vendors - T	2		1

				- Ethics in AI Examples of AI in real world - T							
	5	4,5	3	Why Do We Need a Version Control System? Fundamentals of Git Git installation and setup basic local Git operations ▪ creating a repository, ▪ cloning a repository, ▪ making and recording changes ▪ staging and committing changes, ▪ viewing the history of all the changes ▪ undoing changes	1		3	Git Branching and merging Basic ▪ Creating and switching to new branches ▪ Switching between branches ▪ Merging local branches together			3
	5	4,5	4	GitHub - Basics of distributed git - Account creation and configuration - Create and push to repositories - versioning - Collaboration - Migration	1		3	Create repository – named mini project-1 Push the same to GitHub TOC - Git Essentials: Become a Git and GitHub Ninja | Infosys Springboard (onwingspan.com)			3
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	1	**1,5**	6	Real industry experience of AI	2		3	Weekly Assignment(1PM-2PM)			
2	1	1	1	Peer Review		4		**Machine Learning**	2		1

								- Fundamentals - Machine learning types - Machine learning workflow - Machine learning applications - Challenges in ML - Building a model – steps involved - Pipelines ▪ Data engineering ▪ Machine learning ▪ Deployment - What is Data Science? - How Data Science works? - Data Science uses Group discussion - Examples of ML in everyday life / Use of Machine Learning in Daily Life Machine Leaning Terminologies - T TOC - Machine Learning Fundamentals | Infosys Springboard (onwingspan.com) Prediction – continuous value			
	1,5	1,4	2	Introduction to Cloud Computing - Essentials of Cloud Computing - Cloud Deployment Models - Cloud Service Models	2		2	Introduction to Containers Cloud Native application development Explore AI (ML and DL) services across public cloud platforms	1		2

				- Serverless Services - Major Cloud service Providers - Virtualization Explore the cloud service providers and services offered by them - T				Note : teacher has to choose a public cloud platform to perform the fallowing activities - Getting to know cloud platform - Creating an account			
	1,5	**4,5**	3	- Walking through the administrative console and Cloud SDK - Explore Virtual machines (PaaS, Iaas and SaaS) and storage options - Deploy a simple application on the cloud - AI Platform overview	1		3	Essentials of cloud billing SLA TOC - Essentials of Cloud Computing | Infosys Springboard (onwingspan.com) Tutorial - Automatically Create Machine Learning Models - Amazon Web Services Tutorial - Automatically Create Machine Learning Models - Amazon Web Services	1		2
	1	1,3 4	4	Big Data - What is Big Data? - Vs of Big Data - Sources of data - Role of Big Data in AI&ML Python Packages for Machine Learning and Deep Learning - Scientifics computing libraries - Visualization Libraries - Algorithmic libraries Environment setup: install required packages	1		3	Python recap Database connectivity	1		2

				Explore above listed packages							
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	1,5	**2,3 ,4**	6	Build applications using AI cloud services	2		3	Weekly Assignment			
3	**1,5**	**2,3 ,4**	1	Peer review		4		Explore NumPy Module - Array Aggregation Functions - Vectorized Operations - Use Map, Filter, Reduce and Lambda Functions with NumPy - TOC - Pandas and NumPy Tips, Tricks, and Techniques | Infosys Springboard (onwingspan.com)			3
	1,5	**2,3 ,4**	2	Explore Pandas modules - Aggregation and Grouping - Time Series Operations - Pivot and melt function - Use Map, Filter, Reduce and Lambda Functions with Pandas dataframes - TOC - Unpacking NumPy and Pandas | Infosys Springboard (onwingspan.com)	1		3	Contd.			3
	2,5	**2,3 ,4**	3	**Data visualization with python** - Visualization fundamentals - Why visualization	2		2	- Visualizing Amounts - Visualizing distributions			3

				- Coordinate Systems and Axes - Directory of Visualizations Amounts, Distributions, Proportions, x-y Relationships, Uncertainty Basics of python visualization with Matplotlib - Understand the anatomy of a figure - Plot creation - Plotting routines - Basic plot customizations - Saving plots				- Visualizing proportions - Visualizing associations - Visualizing time series **Consider a dataset and infer the relations with the help of different plots.**			
	2,5	2,3, 4	4	- Visualizing trends - Visualizing uncertainty - Visualizing categorical data - visualize proportions - visualize data on multi-plot grid - Composite views for informative summaries of data	1		3	Basics of python visualization with Seaborn The Course Overview - Viewer Page | Infosys Springboard (onwingspan.com)			3
			5	**CIE 1 – Written and Practice Test**				Assessment Review and corrective action			3
	1	4	6	How to create project plan and product backlog for AI project Create Git Repository for following Regression Project - ML / deep learning	2		3	Weekly Assignment			

				Classification Project – ML / deep learning Clustering project – ML / deep learning Natural Language Processing – ML / deep learning							
4	2	**2,3,4**	1	**Peer review** **Mini Project Activity (2)** - **Regression** - **Classification** **(Individual/ Team of 2)** - Define Problem statement (solution to be presented at the semester end) - Create project plan and product backlog - Create git repository for the project - Work progress should be monitored weekly		4		**Data engineering pipeline** **Data Collection** - Population and sample - Types of data ▪ Data type (type 1 (cross sectional, time series), type 2 (univariate, multivariate)) ▪ Variable types (categorical, ordinal, ratio, interval) - Data Collection Key terminologies in Statistics – T **<u>Mini Project Activity</u>** - Data collection for the stated problem	2		1
	2	1,3	2	**Probability** - **Basic concepts** - Conditional and Joint probability - Bayes' Theorem Probability Distributions - Discrete	2		2	**Exploratory data analysis** - overview - EDA goals and benefits **Univariate data analysis** - Characterizing data with descriptive statistics - Univariate distribution plots	1		2

				- Continuous - Central Limit Theorem Infosys Springboard (onwingspan.com) TOC - Probability Distribution using Python | Infosys Springboard (onwingspan.com) **Use relevant python packages to compute Central tendency for the parameters Dispersion for the parameters** **data distribution** **Visualize above computation with various techniques**				- Univariate comparison plots - Univariate composition plots **Mini Project Activity** Data Exploration and analysis for the stated problem			
	2	**2,3 ,4**	3	**Univariate analysis tests** Hypothesis testing Error, Test statistic, type, interpreting test statistics. Understanding p-value	1		3	**Multivariate analysis** Finding relationship in data - Covariance - Correlation	1		2
	2	**2,3 ,4**	4	- Multivariate distribution plot Multivariate comparison plot Multivariate relationship plot Multivariate composition plot			4	**Linear algebra using python** - Scalars - Vectors - Matrices - Tensors Gradients	1		2

				- TOC - Exploratory Data Analysis with Pandas and Python 3.x | Infosys Springboard (onwingspan.com) **Mini Project Activity – Status review** (Data Exploration and analysis for the stated problem)				- **E**igen values and eigen vectors - Norms and Eigen decomposition **Use relevant python packages to perform operations over vectors and matrices.** TOC - Basics of Linear Algebra using Python | Infosys Springboard (onwingspan.com) Interactive Scenario: Introduction to Vector Algebra Using Python (oreilly.com)			
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	2	**2,3 ,4**	6	Statistics and Linear algebra	2		3	Weekly assignment			
5	2,5	**2,3 ,4**	1	Peer review **Mini Project Activity – Status review**		4		**Data Preprocessing** Importance of data preprocessing **Data cleaning** - Assess Data quality - Data anomalies - Detect missing values with pandas dataframe functions: .info() and .isna() - Diagnose type of missing values with visual and statistical methods (eg. chi-squared test of independence) Approaches to deal with missing values ▪ Keep the missing value as is	1		2

								▪ Remove data objects with missing values ▪ Remove the attributes with missing values ▪ Estimate and impute missing values			
	2,5	**2,3 ,4**	2	Practice: Dealing with missing values with different approaches Outliers Detecting outliers ▪ univariate outlier detection ▪ bivariate outlier detection ▪ Time series outlier detection	1		3	Dealing with outliers - Do nothing - Replace with the upper cap or lower cap - Perform a log transformation - Remove data objects with outliers Practice: Dealing with outliers with different approaches TOC - Data Preprocessing | Infosys Springboard (onwingspan.com) TOC - Data Cleaning and Transformation | Infosys Springboard (onwingspan.com)			3
	2,5	**2,3 ,4**	3	Data Integration - Overview - data integration challenges - Approaches - Adding attributes - Adding data objects Practice: data integration	1		3	Data reduction - Distinction between data reduction and data redundancy - Objectives - Methods ○ numerosity data reduction ○ dimensionality data reduction	1		2

								Practice: Data reduction with numerosity data reduction method			
	2,5	**2,3 ,4**	4	Data transformation Need for data transformation. - **Normalization** - Standardization Data transformation with - binary coding - ranking transformation - discretization	1		3	Data transformation with - ranking transformation - discretization			3
			5	**CIE 2 – Written and Practice Test**				Assessment Review and corrective action			3
	2,5	**2,3 ,4**	6	**Feature engineering**	2		3	Weekly Assignment			
6	**2,3 ,5**	**2,3 ,4**	1	Peer review **Mini Project Activity – Status review**	4			**Data Splitting** Importance of data splitting - Training set - Validation set - Testing set Underfitting and overfitting Practice : split training and testing data sets in Python using train_test_split() of sci-kit learn. Explore the options of train_test_split()	1		2

	2,3,5	**2,3,4**	2	**Machine Learning pipeline: Model training** - Supervised Learning: Regression - What is Regression? - Types of regression - Regularization in ML - Real-Life Applications - T - Linear regression Overview Types - simple linear regression - Multiple linear regression - Polynomial linear regression Applications of Linear Regression - T	2		2	Understanding Simple linear regression - Regression equation - Assumptions - Gradient descent - Setting up the regression problem Practice: student score based on study hours Problem statement: • Create a model to analyses the relation between CIE and SEE result • Create a model to analyze the relation between crop yield and rain fall rate Build linear regression model using - Stats model - Scikit learn	1		2
	2,3,5	**2,3,4**	3	**Model Evaluation & testing** Evaluate regression model: Evaluation Metric - Coefficient of Determination or R-Squared (R2) - Root Mean Squared Error (RSME) - Optimize regression model - Gradient descent	2		2	Cross-validation Why do we need Cross-Validation? Techniques - Hold out method - Leave One Out Cross-Validation - K-Fold Cross-Validation	1		2

	2,3 ,5	**2,3 ,4**	4	Multiple Linear Regression - Overview - Assumptions - Normal Equation - Applications Identification and collection of regression dataset - T Perform data exploration, preprocessing and splitting on datasets like - Boston housing price from sci-kit learn datasets - Cricket match result - past data - Performance of a cricket player - past data - Crop yield - past data	2		2	Implementation in python - Build regression model - Evaluate the model - To minimize the cost function			3
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	2,3 ,5	**2,3 ,4**	6	**Optimization and performance matrices for regression**	2		3	Weekly Assignment			
7	**2,3 ,5**	**2,3 ,4**	1	Peer Review **Mini Project Activity – Status review**		4		Explore other regression algorithms - T Rebuild the model with other regression algorithms such as - Random Forest Regressor - Support Vector Regression - Lasso regression			3

								Evaluate and compare the performance of each.			
	2,3 ,5	**2,3 ,4**	2	Supervised learning – classification What is classification? Types: - Binary classification - Multi-Label Classification - Multi-Class Classification - Imbalanced Classification Classification models Applications - T Practice: Iris dataset from sci-kit learn Perform data exploration, preprocessing and splitting	2		2	Decision trees - What is decision tree? - Understanding Entropy, information gain - How to stop overfitting - Pruning DecisionTreeClassifier - How it works? - Understanding the parameters - Applications	3		
	2,3 ,5	**2,3 ,4**	3	Build decision tree-based model in python for like Breast Cancer Wisconsin (diagnostic) dataset from sci-kit learn Or any classification dataset from UCI , Kaggle			4	Evaluation Metrics for Classification - confusion matrix, - Accuracy - Precision and Recall - Specificity - F1-score - AUC-ROC ▪ How to compute ▪ How does it work	1		2

								▪ When to use			
	2,3,5	**2,3,4**	4	Evaluation Metrics for Classification- contd. Evaluation of decision tree model with different metrics			4	Hyper parameter tuning for DecisionTreeClassifier			3
			5	**CIE 3 – Written and Practice Test**				Assessment Review and corrective action			3
	2,3,5	**2,3,4**	6	Hyper parameter tuning for classification	2		3	Weekly Assignment			
8	**2,3,5**	**2,3,4**	1	Peer review **Mini Project Activity – Status review**		4		Logistic regression - Overview - Types - How does logistic regression work? - Assumptions - Understanding sigmoid function - Applications Practice: build Logistic regression model in python	1		2
	2,3,5	**2,3,4**	2	build Logistic regression model in python Evaluation and optimization of the model	2		2	Support Vector Machine - Introduction to SVM - How does it work? - Applications Practice: Build a SVM Model in python for Fish dataset from Kaggle	2		1
	2,3,5	**2,3,4**	3	Build a SVM Model in python			4	**Ensemble Learning**			3

				How to optimize SVM?				Introduction Basic Ensemble Techniques - Max Voting - Averaging - Weighted Average Advanced Ensemble Techniques - Stacking - Blending - Bagging - Boosting Explore and list the Ensemble Algorithms - T Random Forest - Introduction - How does it work? - Hyper parameters - Applications			
	2,3 ,5	**2,3 ,4**	4	Build Random Forest-based model in python for Breast Cancer Wisconsin (diagnostic) dataset from sci-kit learn Or dataset from UCI , Kaggle			4	Evaluation and optimization			3
			5	**Development Assessment**				Assessment Review and corrective action			3
	2,3 ,5	**2,3 ,4**	6	Comparison of classification algorithms with real world scenario	2		3	Weekly Assignment			

9	3	2,3	1	Peer review **Mini Project Activity – Status review**		4		Unsupervised learning – - What is unsupervised learning? - Common approaches - Challenges - Clustering Types Applications of unsupervised learning - T K-means – Working of K-means How to Choose the Right Number of Clusters?	2		1
	2,3 ,5	**2,3 ,4**	2	**Implementation in python** Evaluation Metrics - Inertia - Dunn Index Evaluate the model using mentioned metrics	1		3	**Contd.**			3
	2,3 ,5	**2,3 ,4**	3	Dimensionality Reduction - Importance of Dimension Reduction in machine learning Common methods to perform Dimension Reduction - T Dimensionality Reduction using PCA in python	2		2	Dimensionality Reduction using PCA in python			3
	5	4,5	4	MLOps - Overview	2		2	- Monitoring - Deployment			3

				- Why MLOps? - ML pipeline - Versioning - Model registry				- Model monitoring			
			5	**CIE 4 – Written and Practice Test**				Assessment Review and corrective action			3
	4	2,3	6	Compare various clustering techniques	2		3	Weekly Assignment			
10	1	3,4	1	Peer review **<u>Mini Project Activity (2)</u>** - Regression - Rebuild with deep learning model - Classification - Rebuild with deep learning model - Analyze the performance of ML and DL **(Individual/ Team of 2)** - Define Problem statement (solution to be presented in the 13th week CIE – 6) - Create project plan and product backlog - Create git repository for the project Work progress should be monitored weekly		4		**Deep learning** - Limitations of Machine Learning - What is deep learning? - Deep learning models - Deep Learning Applications - Deep learning frameworks Group discussion – T Future -Impact deep learning will likely to have on a variety of industries in the next few years. Environment setup - Local - Cloud TOC - Deep Learning with TensorFlow | Infosys Springboard (onwingspan.com)	2		1
	2,3	3,4	2	Introduction to Neural Networks ▪ Understanding	2		2	Introduction to TensorFlow - What is TensorFlow?	1		2

				- Biological Neurons - Artificial neuron /Perceptron - Working of perceptron ▪ Neural network - Architecture - Working of NN - Forward propagation - Back propagation ▪ Activation function - Sigmoid - Tanh - ReLU - LeakyReLU ▪ Cost function - How to measure loss? - How to reduce Loss? - Gradient Descent Get data, and explore Eg. Stroke Prediction Dataset | Kaggle or dataset from any other source Prepare data: Dealing with - missing values - Categorical values				- Why TensorFlow? - TensorFlow ecosystem - TensorFlow architecture - Program Elements in TensorFlow Keras - What is Keras? - Keras APIs – three programming models - Sequential Model - Functional API and - Model Subclassing - Keras layers - Custom Keras Layers TOC - Deep Learning with TensorFlow | Infosys Springboard (onwingspan.com) TOC - TensorFlow for Beginners | Infosys Springboard (onwingspan.com)			

				- Labeled encoding - One hot coding Prepare data : Feature scaling with StandardScalar() or other method Dropping unnecessary features Data splitting Dealing with imbalanced dataset							

	3	2,3, 4	3	- Why do we have to flatten the input data?
				- Understand Keras Dense Layer
				  - Overview
				  - Parameters
				  - Operation
				- Building Shallow Neural Network with Keras Dense Layer
				- Building Deep Neural Network with Keras Dense Layers
				- Create a complete end to end neural network model using Keras Sequential Model and Keras Layer API
				Eg.
				MNIST dataset (classify handwritten numerals) or fashion-MNIST dataset or dataset from other source
					1		3	Keras optimizers
								Keras Metrics
								Keras Losses
								Create a complete end to end neural network – Contd.
								TOC - Learning TensorFlow 2.0 | Infosys Springboard (onwingspan.com)
									1		2

	3	3,4	4	Keras - Callbacks - Commonly used callbacks Monitor neural network performance with TensorBoard - TensorBoard Basics - TensorBoard Setup Understand Model Behavior During Training Reduce overfitting with Dropout Layer	1		3	How to save trained model Local deployment with TensorFlow ModelServer			3
			5	**Development Assessment**				Assessment Review and corrective action			3
	2,3	3,4	6	Building deep learning model with TensorFlow and Keras for use cases	2		3	Weekly Assignment			
11	1,5	2,3, 4	1	Peer Review **Mini Project Activity – Status review**		4		Natural Language Processing Understanding natural language processing NLP approaches – rule based, statistical NLP use cases How to use dictionary? Commonly used NLP tools & libraries Setup environment (spaCy or similar nlp package)	2		1
	2,3	2,3, 4	2	Text processing tasks (Processing Words)	1			Spell Correction	1		2

				Document Assembler Annotation Tokenization - Sentence tokenization - Word tokenization - Visualize frequency distribution of words - Visualize with word cloud Stop word - Dropping stop words - Dropping punctuations			3	Normalization - Stemming - Lemmatization			
	2,3	3	3	Parts of speech tagging Named Entity Recognition	1		3	Vectorizer N-Gram	1		2
	2,3	2.3, 4	4	TF-IDF Build a pipeline for text processing	1		3	Contd.			3
			5	**CIE 5 – Written and Practice Test**				Assessment Review and corrective action			3
	3	2,3	6	NLP – text summarization	2		3	Weekly Assignment			
12	1	2,3, 4	1	Peer review Mini Project Activity – Status review				NLP use case – Sentiment Analysis (SA) What is sentiment analysis? Why is SA important? Business applications for SA How does sentiment analysis work? Transformers	1		2

								Conduct Sentiment analysis to classify movie reviews with - spaCy - TensorFlow and keras			
	1,2,3,4,	2,3,4,6	2	NLP use case – Sentiment Analysis (SA) Contd.			4	Ethics in AI - Importance of AI ethics - Ethical challenges of AI - AI code of ethics Group Discussion: Discussion on the Ethics of AI Ethics of AI: Safeguarding Humanity | Professional Education (mit.edu)	1		2
	5	2,3,4	3	Containers Why containers? What is a docker? How docker works? Components of docker - Docker container - Docker client - Docker daemon - Docker image - Docker registry Install docker on desktop and start the docker tool.	2		2	Publish the container in Registry			3

				TOC - Containers & Images | Infosys Springboard (onwingspan.com) Docker file Docker image Commands to create docker file. Build docker image with docker file create docker container from docker image Run the docker container TOC - Deploying and Running Docker Containers | Infosys Springboard (onwingspan.com) TOC - Docker, Dockerfile, and Docker-Compose (2020 Ready!) | Infosys Springboard (onwingspan.com)						
	5	3,4	4	Deployment strategies	1		3	Contd.			3
			5	**Development Assessment**				Assessment Review and corrective action			3
	1,3	5	6	Using cloud service for MLOps	2		3	Weekly Assignment			

References

Sl. No	Description
1	Hands-On Artificial Intelligence for Beginners By Patrick D. Smith
2	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, By Aurélien Géron
3	Machine Learning with Python for everyone, Mark E Fenner
4	Hands on Data processing in Python , Joy Jafari
5	Deep Learning with TensorFlow2 and Keras , Antonio Gulli, Amita Kapoor,Sujith Pal
6	Cloud Computing, Concepts, Technology and Architecture by Thomas Erl
7	Khan Academy
8	Fundamentals of Data Visualization, Claus O. Wilke
9	Pro Git ,Scott Chacon, Ben Straub
10	Mathematics for Machine Learning, A. Aldo Faisal, Cheng Soon Ong, and Marc Peter Deisenroth
11	Machine Learning, Pipelines, Deployment and MLOps Tutorial | DataCamp
12	MLOps Python Tutorial for Beginners -Get Started with MLOps (projectpro.io)

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS

Course Code- **L:T:P-**

Course Description:

This course provides polytechnic students with a foundational understanding of the entrepreneurial mindset, processes, and skills required to identify opportunities, develop innovative solutions, and create sustainable ventures. Throughout the semester, Critical Thinking, Excellent communicator (Good story teller), and Empathetic Leadership skills development for the students, through a blend of theoretical concepts, case studies, and practical exercises, students will learn to think like entrepreneurs, fostering creativity, problem-solving, and a proactive approach to career and economic development. The course emphasizes practical tools and methodologies applicable across various technical and vocational fields. This course will focus towards small Businesses including services and products

---

Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

1. **Define and explain** core concepts of entrepreneurship, innovation, and small business management.
2. **Identify and evaluate** entrepreneurial opportunities using various ideation and market research techniques.
3. **Develop a basic business model** using tools like the Business Model Canvas.
4. **Understand fundamental aspects** of market analysis, competitive landscape, and target customer identification.
5. **Articulate key considerations** in managing startup finances, legal structures, and intellectual property.
6. **Develop and deliver a compelling pitch** for a new business idea.
7. **Cultivate an entrepreneurial mindset**, including adaptability, resilience, and a willingness to take calculated risks.

Course Content Outline (Weekly Breakdown):

Unit 1: Understanding Entrepreneurship and the Entrepreneurial Mindset (Weeks 1-2)

- **Week 1: What is Entrepreneurship? The Journey Begins.**
  - Definition of entrepreneurship, innovation, and intrapreneurship.
  - Dispelling myths about entrepreneurs.
  - The role of entrepreneurship in economic development and job creation (local and global context).
  - Types of entrepreneurships: lifestyle, scalable, social, tech, side-hustle.
  - Introduction to JUT's entrepreneurial ecosystem and local success stories
  - ***Activity:*** **Ice-breaker: "What problem bothers you the most in your daily life/local community?"**
- **Week 2: The Entrepreneurial Mindset & Traits of Successful Entrepreneurs.**
  - Key entrepreneurial characteristics: passion, resilience, adaptability, creativity, risk-taking (calculated), problem-solving.
  - Growth mindset vs. fixed mindset.
  - Identifying personal strengths and weaknesses as potential entrepreneurs.
  - Importance of networking and mentorship.
  - *Case Study:* Analyze a local polytechnic graduate who started a successful business.

- *Activity:* **Self-assessment quiz: "Are you ready for entrepreneurship?"**

Unit 2: Opportunity Identification & Ideation (Weeks 3-4)

- **Week 3: Finding Your Big Idea: Problem-Solving Approach.**
  - Sources of entrepreneurial opportunities: pain points, market gaps, trends, technological advancements, personal hobbies/skills.
  - Design Thinking principles for problem identification.
  - Techniques for observing and understanding customer needs (empathy mapping).
  - *Activity:* **Field observation exercise: Identify 3 problems in a chosen environment (e.g., campus, local market).**
- **Week 4: Ideation & Validation Techniques.**
  - Brainstorming methods: SCAMPER, S- Substitute, C-Combine, A- Adapt, M- Modify, P- Put to another Use, E-Eliminate, R- Reverse/Rearrange (Mind Mapping, Reverse Brainstorming)
  - Concept generation and prototyping
  - Introduction to Minimum Viable Product (MVP) concept.
  - Initial idea validation: informal surveys, interviews with potential customers.
  - *Activity:* **Group ideation session for a chosen problem; develop a basic MVP concept.**

Unit 3: Business Model Fundamentals (Weeks 5-6)

- **Week 5: Introduction to the Business Model Canvas (BMC).**
  - Understanding the nine building blocks of the BMC: Customer Segments, Value Propositions, Channels, Customer Relationships, Revenue Streams, Key Resources, Key Activities, Key Partnerships, Cost Structure.
  - How the BMC provides a holistic view of a business.
  - *Activity:* Analyze the BMC of a well-known local or global company.
- **Week 6: Developing Your Value Proposition & Customer Segments.**
  - Deep dive into Value Proposition Design: understanding customer jobs, pains, and gains.
  - Defining your ideal customer segments: demographics, psychographics, behaviors.
  - Niche markets vs. broad markets.
  - *Activity:* **Students start populating the Customer Segments and Value Propositions blocks of their own business idea's BMC.**

Unit 4: Market Analysis & Strategy (Weeks 7-8)

- **Week 7: Market Research Essentials.**
  - Importance of market research: primary vs. secondary research.
  - Basic tools for market research: online surveys (e.g., Google Forms), competitor analysis, industry reports.
  - Analyzing market size, trends, and growth potential.
  - *Activity:* **Conduct preliminary secondary market research for their chosen industry.**
- **Week 8: Understanding Your Competition & Marketing Basics.**
  - Competitor analysis: identifying direct and indirect competitors, SWOT analysis (Strength, Weakness, Opportunity, Threat).
  - Developing a competitive advantage.
  - Introduction to the Marketing Mix (4 Ps: Product, Price, Place, Promotion) in a startup context.
  - Branding basics for new ventures.
  - *Guest Speaker (Optional):* Local entrepreneur sharing marketing strategies.

Unit 5: Financial, Legal & Operational Foundations (Weeks 9-11)

- **Week 9: Startup Financial Basics.**

    - Understanding startup costs (fixed vs. variable).
    - Revenue models: how businesses make money.
    - Basic concepts of pricing strategies.
    - Sources of funding: bootstrapping, FFF (Friends, Family, Bootstrap), grants, basic loans, angel investors (brief overview).
    - ***Activity:*** **Calculate initial startup costs for their business idea.**
- **Week 10: Legal & Regulatory Aspects for Startups.**
    - Choosing a business structure: Sole Proprietorship, Partnership, LLC (simple overview, focus on local context).
    - Importance of business registration and licensing.
    - Basic understanding of contracts and agreements.
    - Introduction to Intellectual Property (IP): patents, trademarks, copyrights (relevance to polytechnic innovations).
    - *Guest Speaker (Optional):* Small business lawyer or a representative from a local business registration office.
- **Week 11: Operations & Team Building.**
    - Key operational considerations: supply chain, production/service delivery, quality control.
    - Building an effective founding team: complementary skills, roles, and responsibilities.
    - Importance of company culture in a startup.
    - ***Activity:*** **Define key activities and key partners for their BMC.**

Unit 6: Pitching, Growth, and Next Steps (Weeks 12-14)

- **Week 12: Crafting Your Pitch & Storytelling.**
    - Purpose of a pitch deck.
    - Components of a compelling pitch: problem, solution, market, team, business model, ask.
    - Storytelling techniques for engaging an audience.
    - Verbal and non-verbal communication skills.
    - *Activity:* Students draft their initial pitch script.
- **Week 13: Developing Your Business Plan (Lean Approach) & Refining Your Pitch.**
    - Overview of a lean business plan (as opposed to a traditional, lengthy one).
    - Refining the Business Model Canvas into a more comprehensive plan.
    - Peer feedback session on draft pitches.
    - ***Workshop:*** **Pitch practice session.**
- **Week 14: Final Pitch Presentations & Future Directions.**
    - **Final Project:** Students present their business idea pitch (could be 5-7 minutes with Q&A).
    - Discussion on continuous learning, adaptation, and potential next steps for their entrepreneurial journey.
    - Resources available for aspiring entrepreneurs at JUT and in the local community.
    - *Activity:* Course wrap-up and Q&A.

Assessment Methods:

To ensure a balance between theoretical understanding and practical application, the assessment for this course could include:

- **Participation & Engagement (10-15%):** Active involvement in discussions, group activities, and case study analyses.
- **Module Activities/Quizzes (20-25%):** Short quizzes, completion of assigned BMC sections, market research exercises, ideation assignments.
- **Individual/Group Assignments (30-35%):**
    - **Mid-Term Assignment:** Developed Business Model Canvas for their chosen idea (could be individual or small groups).

    - **Research Report:** A brief report on their market research and competitive analysis.
- **Final Project (30-35%):**
    - **Business Pitch Deck:** A professional-looking presentation outlining their business idea.
    - **Oral Pitch Presentation:** Delivering a concise and compelling pitch to the class (and potentially invited faculty/local entrepreneurs).

Recommended Resources & Tools:

- **Primary Textbook**
- **Online Platforms/Tools: Introduction to Entrepreneurship Dr Prakah Kumar, Raj Jaswa, Ramesh Yadava**
    - Google Workspace (Docs, Sheets, Slides, Forms) for collaboration and surveys. Canva for creating visual aids and pitch decks. URL **https://www.canva.com/**
    - **web.showreelapp.com** Sabeer Bhatia
    - Online market research tools (e.g., Statista, government statistical websites, industry association sites).
    - Whiteboards, sticky notes, and markers for brainstorming sessions.
- **Guest Speakers:** Local entrepreneurs, business development agencies, IP lawyers, startup mentors.
- **Case Studies:** A mix of successful and failed startups, particularly those relevant to polytechnic fields (e.g., tech, engineering, design, trades).

MOBILE & WIRELESS COMMUNICATION

Course Code- **L:T:P**

I. RATIONALE

The next generation of mobile communications technology has already begun to bring various services to consumers and businesses. Mobile communications technology will be one of the most important drivers of industry, economic ,societal growth and will also generate millions of new jobs. This course will develop the skills to maintain the latest wireless communication based applications like Media, Entertainment, Internet of Things (IoT), Smart cities, Education, Vehicular communication etc. This course will account students with revolution in mobile and wireless communication.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry/employer expected outcome through various teaching learning experiences:
"Maintain mobile and wireless communication system"

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1 - Describe concept of cellular mobile communication systems
CO2 - Describe terminologies used in GSM systems,features and its architecture. CO3 - Compare generations of mobile communication system
CO4 - Interpret 5G system architecture.
CO5 - Use relevant wireless technology suitable for various 5G applications.

IV. COURSE CONTENT

Unit	Course Content	Hours
1	**Unit - I Wireless Communication System** 1.1 Radio spectrum bands for mobile & wireless communication. 1.2 Wireless network generations Mobile Radio standards- AMPS, N AMPS, IS -95, GSM, UMTS . 1.3 Cellular fundamentals: cell, cell structure, cluster, reuse factor, minimum reuse distance. 1.4 Basic cellular system : mobile station, base station, traffic channel (Forward and Reverse) , control channel (Forward and Reverse), frequency reuse, channel assignment strategies. 1.5 Mobile communication system-Block diagram, Mobile Phone Unit : Block diagram of 3G, working, features of transmitter, receiver section, Frequency Synthesizer, Control unit ,Logic Unit of Mobile phone, sensors, speakers, camera, touch screen, motion sensors and other common sensors.	

2	**Unit - II Basics of Mobile Communication System.** 2.1 Interference : Co-Channel interference, Adjacent Channel Interference. 2.2 Improving Coverage and capacity in cellular systems: Cell splitting, Sectoring, Microcell Zone concept. Repeaters for range extension 2.3 Global System for Mobile Communication(GSM): Architecture,Features and service aspects, GSM and radio aspects. channel types, GSM call routing , Mobile terminated call & mobile originated call sequence, stages of call processing in GSM.	
3	**Unit - III Fundamentals of 4G Communication** 3.1 Limitation of 3G and motivation for 4G. 3.2 LTE enabler Technologies: LTE(4G) Network architecture including eNodeB, MME, SGW, PGW,HSS, PDN. 3.3 Comparison of 1G ,2G, 3G, 4G ,4.5G, 5G. 3.4 Basics of MIMO. 3.5 Massive MIMO (Advanced Antenna Systems - AAS)Defination,diagram,benefits,Beamforming.	
4	**Unit - IV Introduction to 5G Technology** 4.1 Introduction to 5G: 5G network architecture, 5G enable technologies, 4.2 IMT 2020 standards. 4.3 5G Radio spectrum : low band, medium band,millimeterwave(Ultrahigh) band,5G service providers, 4.4 5G network slicing.	
5	**Unit - V Recent Wireless Technologies & applications** 5.1 Features ,architecture, frequency band of Wi-Fi , IEEE 802.11a & 802.11g 5.2 Features ,architecture, frequency band of Bluetooth- BLE (Bluetooth 4.0, Bluetooth Low Energy), IEEE 802.15.1. 5.3 NFC services , Introduction to 3GPP Release 18 List of services . 5.4 Applications such as Vehicular communication : V2V,Industrial Automation Application(in detail) & other application such as Media and entertainment ,Retail Industry, Education, Industrial Automation ,Smart Cities, Internet of Things (IoT)Application.	

V. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	William C.Y. Lee	Mobile Cellular Telecommunications:	McGraw Hill Education; 2nd edition (1 July 2017); McGraw Hill Education (India) Private Limited. ISBN : 978-0070635999

Sr.No	Author	Title	Publisher with ISBN Number
2	Theodore S. Rappaport	Wireless Communications principles & practice	Pearson Education India; 2nd edition (1 January 2010), ISBN : 978-8131731864
3	T.L.Singal	Wireless Communications	McGraw Hill Education (1 July 2017) (India) Private Limited,New Delhi ISBN : 978-0070681781
4	Leeladhar Malviya, Rajib Kumar Panigrahi, M.V. Kartikeyan.	MIMO Antennas for Wireless Communication	CRC Press; 1st edition (16 December 2020) ISBN : 978-0367530471
5	Simon Haykin,Michael Moher	Modern Wireless Communication	Pearson Education India; 1st edition (1 January 2011), ISBN: 978-8131704431

VI. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.gsma.com/connectivity-for-good/spectrum/5g-spectrum-guide-2/	Spectrum bands
2	https://www.ericsson.com/en/reports-and-papers/white-papers/advanced-antenna-systems-for-5g-networks	5G-networks
3	http://www.eitc.org/research-opportunities/5g-and-beyond-mobile-wireless-technology/5g-and-beyond-technology-roadmap/novel-antennas-and-semiconductor-technology/5g-nr-massive-mimo-technology	MIMO
4	https://telcomatraining.com/what-is-aas-adaptive-antenna-system	AAS antenna
5	https://mobilepacketcore.com/lte-4g-network-architecture/	4G architecture
6	https://www.linkedin.com/pulse/applications-5g-technology-ramya-chandran-swprc	Applications of 5G
7	https://www.rantcell.com/5g-antenna-5g-mmwave-components-for-connectivity.html	mmwave antenna

MOBILE TECHNOLOGY

Under Preparation……..

OPTICAL FIBER COMMUNICATION

Under Preparation……..

SIGNAL & SYSTEM

Under Preparation……..

IIOT

Under Preparation……..

OPEN ELECTIVE

Cyber Security

CYBER SECURITY

Course Code- **L:T:P-**

Introduction:

Welcome to the curriculum for the Artificial Intelligence and Machine Learning (AI&ML) Specialisation. This specialisation course is taught in Bootcamp mode. Bootcamps are 13 weeks, intense learning sessions designed to prepare you for the practical world – ready for either industry or becoming an entrepreneur. You will be assisted through the course, with development-based assessments to enable progressive learning.

In the era of connected computing devices, securing the personal data, application, system, network and organization becomes the challenging task in the field of Computer science and Engineering. The specialization prepare students to take up job or to become entrepreneur in the challenging area of Cyber security

Pre-requisite

Before the start of this specialisation course, you would have completed the following courses;

In the 1st year of study, you would have studied Engineering Mathematics, Communication Skills, Computer Aided Engineering Graphics, Statistics & Analysis, Basic IT Skills, Fundamentals of Computer, Fundamentals of Electrical and Electronics Engineering, Project Management skills and Multimedia & Animation.

In the 2nd year of study, you would have studied Python Programming, Computer Hardware, Maintenance and Administration, Computer Networks, Database System Concepts and PL/SQL, Data Structures with Python, Operating System and Administration, Object oriented programming and Design with Java, Software Engineering principles and practices.

In this year of study, you shall be applying your previous years learning along with specialised field of study Sinto projects and real-world applications.

Course outcome: A student should be able to

CO1	Design, optimize, operate and maintain a secure network/system/application/cloud and data resources for given requirements
CO2	Apply cryptography to secure a cyber system.
CO3	Respond to incidents to mitigate immediate and potential threats .
CO4	Test, implement, deploy, maintain and review the infrastructure to effectively manage the network and resources.
CO5	Monitor network to actively remediate unauthorized activities.

Detailed course plan

Week	CO	PO	Days	1st session (9am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
1	1	1	1	- Protecting your personal data - Online identity - Where is your data ? - Smart devices - What do attackers want ? - Identity theft - Protecting your organization data - Traditional data - Cloud; IoT; Big data - Types of data - Sensitive and non sensitive data - Personal data, PII data - Data classification - Ex: Govt. of India classification of data - Unclassified - Restricted - Confidential - Secret - Top secret -	4	-	-	Introduction and Basic concepts of cyber security What is Cyber security, Security principles CIA, AAA Vulnerability, Threat, Risk, attack and Impact People, Process and Technology McCumbers Cube Cyber Security - Brief history and types - Infrastructure, network, cloud, IOT, application. - Purpose and Importance - Challenges - Applications How does cyber security work?	3		

	1	1,5	2	Recap – Topology OSI Model TCP/IP Model Internet protocols Network resources Router and Firewall, Hub, switch – security issues Basic Network terminologies	3		1	Hackers Who are they? What is not hacking Types of hackers Hacking methodologies Purpose Activity: Stuxnet - a case study	1		2
	1,2, 3	1,2, 3	3	Analysing a Cyber Attack Types of Malwares Spyware Malware Backdoor Ransomware Scareware Rootkit Virus Trojan horse Worms Symptoms of attack Methods of Infiltration Social Engineering Pretexting Tailgating Something for something (quid pro quo) Denial-of-Service and DDoS Botnet On the Path attack	3	1		- Defence in depth - What is defence in depth - Layers - Needs for Defence in depth - Examples - Host encryption - Anti-virus - Firewall - E-Mail gateway - Password management - Honeypot - Multi Factor Auth			3

				SEO Poisoning Wi-Fi Password Cracking Password Attacks Password spraying Dictionary attack Brute force Password Cracking Times Rainbow Traffic interception Advanced Persistent Threats Security Vulnerability and Exploits Hardware Vulnerabilities Meltdown and Spectre Software Vulnerabilities Categorizing Software Vulnerabilities Software updates						
	1,2, 3	1,2, 3	4	Data Maintenance Using free tools Back Up Your Data How Do You Delete Your Data Permanently? Tools Who owns your data? Terms of service Understand the term; what are you agreeing to? The data use policy Privacy settings Before you sign up protect your data Activity: Check terms of service of the popular application you use on your phone and check their data sharing policy, access to device etc.	2	1	1	Protecting Your Computing Devices turn the firewall on install antivirus and antispyware manage your operating system and browser set up password protection.			3

				Safeguarding Your Online Privacy Two Factor Authentication Open Authorization Social Sharing Email and Web Browser Privacy Activity: Discover your own risky online behaviour Scenario 1: posting private info on social media Scenario 2: What password you choose when creating new account for social service Scenario 3: Using public Wi-Fi - Scenario 4: Using trial version of the software Activity: Check if your password is compromised Note :Use Have I been pwned -							
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	1,2	2,3,4	6	**class: Cyber security at workplace**	2		3	Weekly Assignment(1PM-2PM)			
Reference materials : skillsforall.com – Introduction to Cyber security											
2	1,2,3,4	2,3,4	1	Peer review Project / activity Propose problem statement		4		Why Do We Need a Version Control System? Fundamentals of Git Git installation and setup basic local Git operations ▪ creating a repository,	1		2

								▪ cloning a repository, ▪ making and recording changes ▪ staging and committing changes, ▪ viewing the history of all the changes undoing changes			
	2,3	2,3, 4	2	History of cryptography (overview: Caesar cipher, enigma cipher) Introduction (high level overview only) Enc (sym - stream + block ciphers, asym) Hashing Digital signature, MAC - PRNG	2		2	Algebra: groups, rings, fields - definitions + examples AES (SPN structure, rounds, modes of operation - high level overview with diagram) MAC + SHA2/3 (high level + security requirements))	1		2
	2,3	2,3, 4	3	RSA (with numerical examples) Digital signature (RSA)	2		2	Number theory - primes, modular arithmetic, gcd, Euler totient function - definitions + examples	1		2
	2,3	2,3, 4	4	Practice sessions/ student activities: - Numerical/programming exercises: subset of math / Caesar cipher / one time pad / RSA / GCD / primality Cryptanalysis (brute force over keys, birthday attacks on hash functions, hardness of	1		3	Practice sessions/ student activities: Inspect digital certificates using a web browser and visiting popular websites - Identify the crypto algorithms in TLS - Design a toy crypto algorithm like key generation + encryption + decryption / digital signature / hash function			3

				factoring integers, discrete log problem, side-channel attacks – high level overview) Applied crypto (PKI, Full disk encryption, blockchain: overview							
			5	**Developmental Assessment**				Assessment Review and corrective action			3
			6	**Industrial class : Application of cryptography**	2		3	Weekly Assignment			
References : • https://www.youtube.com/user/Computerphile - YouTube channel by Dr. Mike Pound • https://nptel.ac.in/courses/106105031/ : Cryptography and Network Security by Prof. Debdeep Mukhopadhyay, IIT Kharagpur • https://www.coursera.org/learn/crypto and https://www.coursera.org/learn/crypto2 : by Prof. Dan Boneh, Stanford University • http://williamstallings.com/Cryptography/ - student resources by Prof. William Stallings											
3	1,4	2,3, 4	1	Peer review Project / activity Propose problem statement and network design requirements		4		How Internet/Application works (Security aspects – end-to-end packet path) Network architecture concepts Understanding vulnerabilities in different OSI layers and protocols (TCP, UDP, IP, ICMP)			3

	1,5	2,3, 4	2	Network Security : Concepts- Firewall, IDS, IPS, VPN	2		2	Protocols : IPSec, SSL, TLS (versions and vulnerabilities)	1		2
	1,5	1,4	3	Web Security : Concepts-HTTP, HTML, Frames, browser design	2		2	Attacks and vulnerabilities: Injection attacks : SQL, HTTP header, OS command	1		2
	1,5	2,3, 4	4	○ Wireless Security : Introduction to security issues in cellular networks, WIFI, LAN systems, RFID systems	2		2	- DOS attacks, countermeasures (in relation to wireless networks)	1		2
			5	**CIE 1 : Written and practice test**				Assessment Review and corrective action			3
	2,3	2,3, 4	6	**Industrial class :** High availability and load balancing	2		3	Weekly Assignment			
References : 1. https://www.cisco.com/c/en_in/products/security/what-is-network-security.html 2. https://purplesec.us/firewall-penetration-testing/ 3. How hackers do it: Tricks, Tools, and Techniques 4. https://cse29-iiith.vlabs.ac.in/ 5. https://nptel.ac.in/courses/106105031/ : Cryptography and Network Security by Prof. Debdeep Mukhopadhyay, IIT Kharagpur. 6. https://wiki.apnictraining.net/netsec-20220627-bdnog14/agenda											
4	2,3, 5	2,3, 4	1	Peer review Project status review Demonstration of artifacts of the project		4		Windows Security Windows Security Infrastructure Windows Family of Products Windows Workgroups and Accounts Windows Active Directory and Group Policy	2		1

	1,2, 3,5	2,3, 4	2	Windows as a Service End of Support Servicing Channels Windows Update Windows Server Update Services Windows Autopilot Windows Virtual Desktop Third-Party Patch Management Practice : Process observation and analysis with Process Hacker	2		2	Windows Access Controls NTFS Permissions Shared Folder Permissions Registry Key Permissions Active Directory Permissions Privileges BitLocker Drive Encryption Secure Boot - Practice : NTFS file system practical using NTFS Permissions Reporter	1		2
	1,2, 3,5	2,3, 4	3	Enforcing Security Policy Applying Security Templates Employing the Security Configuration and Analysis Snap-in Understanding Local Group Policy Objects Understanding Domain Group Policy Objects Administrative Users Privileged Account Management Reduction of Administrative Privileges AppLocker User Account Control Windows Firewall IPsec Authentication and Encryption	2		2	Linux Security Linux Fundamentals Operating System Comparison Linux Vulnerabilities Linux Operating System Shell Kernel Filesystem Linux Unified Key Setup Linux Security Permissions Linux User Accounts Pluggable Authentication Modules Built-in Command-Line Capability	1		2

				Remote Desktop Services Recommended GPO Settings. Practice : Auditing and enforcement of system baseline configurations with security templates PowerShell scripting and automation techniques				Service Hardening Package Management			
	1,2, 3,5	2,3, 4	4	Linux Security Enhancements and Infrastructure Operating System Enhancements ○ SE Linux ○ App Armor Linux Hardening ○ Address Space Layout Randomization ○ Kernel Module Security ○ SSH Hardening ○ Open SCAP ○ CIS Hardening Guides and Utilities	2		2	Log Files ○ Key Log Files ○ Syslog ○ Syslog Security ○ Log Rotation ○ Centralized ○ Logging ○ Audit id ○ Firewalls: Network and Endpoint ○ Rootkit Detection	1		2
			5	**Development Assessment** (Hardening the image win and linux CIS controls)				Assessment Review and corrective action			3
	1,2, 3,5	2,3, 4	6	Industrial Class : System Security	2		3	Weekly Assignment			
5	1,2, 3,4, 5	2,3, 4	1	Peer review Project status review		4		Introduction to Application Security Secure SDLC	2		1

				Introduction to Software Application Development – How was it created, Why is it important? How does it work. Types of Application Software – Thick Client, Web Applications, Web Services, RESTFul Services, Middle Ware, Mobile Applications etc (Give an example of each). Explain Software Development Lifecycle – Requirements, Design, Develop, Deploy, Operate and Purge. Life Cycle Models – Waterfall, Agile, Iterative etc. SDLC Best Practices				Provide a use case – Microsoft Secure SDLC Practice and Security controls covered in each stage at a higher level. Requirements (Determine Application Risk Profile based on Security Requirements, Determine Control Requirements, Establish Quality Gates) b. Design (Architecture Design Review and Threat Modeling) c. Implementation (Static Analysis, Software Composition Analysis, Secret Detection, Deprecate unsafe functions, use of plugins in IDE, Safe Commit and Change Management in Repositories) d. Verification (Dynamic Analysis, Interactive Application Security Testing, Fuzz Testing, Abuse use case Testing, Architecture Verification). e. Release (Run Time Application Self Protection, Web Application Firewall, SOP for Operations, Secure Provisioning, Deployment and De commissioning) - f. Response (Incident Response).			

	1,3, 4,5	2,3, 4	2	Application Security – Requirements 1. Functional and Non Functional Requirements for an application 2. Security Requirements for an application 3. Determining Application Risk Profile Based on the security requirements. 4. Determining Control Requirements Based on Application Risk Profile and Eligibility Criteria for an application to undergo a certain security control. Establish Security Toll Gates	1		3	Application Security Design: Secure Architecture Review – For a given use case, with examples; conduct security architecture review using the OWASP standard.	1		2
	1,3, 4,5	2,3, 4	3	Application Security Design – Threat Modelling. 1. Why Threat Modelling 2. What is Threat Modelling 3. Threat Modelling Methodologies – STRIDE, PASTA, OCTAVE, TRIKE, VAST. 4. Threat Model Ranking – DREAD, CVSS, CWSS etc. Threat Model Execution Phases: - Planning, Scoping, Deep Dive Discussions, Drawing a	1		3	- Using the Microsoft Threat Modeling methodology, execute a threat model for a given application architecture using Microsoft threat modeling tool.			3

				Threat Model, Identifying Threats, Threat Objects, Security Controls, Threat Actors, Threat Traceability Matrix, Reporting and Debrief.							
	1,3, 4,5	2,3, 4	4	Application Security – Implementation - Explain use of Security Tools within IDE. - Static Code Analysis Tools – Explain with examples. - Explain Software Composition Analysis, Identifying Software Dependencies and CVE in underlying libraries. Demonstrate a tool like OWASP Dependency Check.	1		3	Explain Secret Detection using tools like Githound. - Change Management during pre-commit and post-commit in repositories. - Safe SCM practices (Take Github as an example). - Highlight deprecated unsafe functions in common programming languages.			3
			5	**CIE 2 – Written and Practice Test**				Assessment Review and corrective action			3
	1,2, 3,4, 5	2,3, 4	6	**Industrial class : Source Code Scan using a commercial tool like Microfocus Fortify or Checkmarz.**	2		3	Weekly Assignment			
6	1,2, 3,5	2,3, 4	1	Peer review Project status review		4		Application Security – Verification. Explain Dynamic Analysis using an example – owasp zap. Interactive Application Security Testing – Demonstrate using Contrast Security Tool.			3

	2,3,5	2,3,4	2	For a given site (local), conduct a dynamic analysis scan using OWASP ZAP, Check for False positives and create a report			4	Introduce Manual Security Testing using OWASP Testing Guide. Add Misuse case testing to the framework in addition	1		2
	2,3,5	2,3,4	3	Conduct a manual security testing for a local web application or an API using proxy tools like burp suite/paros etc and provide a report. Compare the results of both manual and automated scans. Application Security – Release 1. Explain Run Time Application Self Protection – Contrast Security or Microfocus Fortify Software can be used as an example. 2. Define Web Application Firewall. Demonstrate using a tool. Elaborate on Standard Operating Procedure for Operations, Secure Provisioning, deployment and decommissioning	1		3	- 1. Cover OWASP ASVS and its aid as a tool in architecture verification. Introduce OWASP SAMM – to attain software assurance maturity.	1		2
	2,3,5	2,3,4	4	Measurement of Application Security – Define Metrics, Type of Metrics (Operations, Efficiency, Quality etc). Example Application Security Metrics from OWASP.	1		3	For the previous run scans, define metrics and evaluate the values at operational level.			3

			5	**Development assessment**				Assessment Review and corrective action			3
	2,3, 5	2,3, 4	6	**Industrial class : Dynamic Analysis using Qualys**				Weekly Assignment Weekly Assignment (Suggestive Student Activities) 1. Install Web Goat and do an automated scan using one of the dynamic analysis tools. 2. Follow up with a manual security testing with OWASP Testing guide as an aid and compare the results of automated and dynamic scan.			

References:

1. https://www.synopsys.com/glossary/what-is-sdlc.html
2. https://www.synopsys.com/blogs/software-security/secure-sdlc/
3. https://www.microsoft.com/en-us/securityengineering/sdl
4. https://www.microsoft.com/en-us/securityengineering/sdl/threatmodeling
5. https://www.microsoft.com/en-in/download/details.aspx?id=49168
6. https://medium.com/@melsatar/software-development-life-cycle-models-and-methodologies-297cfe616a3a
7. https://owasp.org/www-project-application-security-verification-standard/
8. https://resources.infosecinstitute.com/topic/application-architecture-review/
9. https://owasp.org/www-community/controls/Static_Code_Analysis
10. https://owasp.org/www-project-web-security-testing-guide/
11. https://owasp.org/www-project-zap/
12. https://owasp.org/www-project-dependency-check/
13. https://www.synopsys.com/glossary/what-is-software-composition-analysis.html
14. https://owasp.org/www-project-samm/
15. https://github.com/tillson/git-hound
16. https://owasp.org/www-project-security-qualitative-metrics/
17. https://www.qualys.com/apps/web-app-scanning/
18. https://www.veracode.com/security/interactive-application-security-testing-iast
19. https://en.wikipedia.org/wiki/Runtime_application_self-protection
20. https://en.wikipedia.org/wiki/ModSecurity

21. https://github.com/WebGoat/WebGoat 22. https://spectralops.io/resources/how-to-choose-a-secret-scanning-solution-to-protect-credentials-in-your-code/ 23. https://www.geeksforgeeks.org/functional-vs-non-functional-requirements/ 24. https://owaspsamm.org/model/design/threat-assessment/stream-a/ 25. https://docs.42crunch.com/latest/content/concepts/security_quality_gates.htm											
7	1,3, 4	2,3, 4	1	Peer review Project status review		4		Basics of cloud computing Why is cloud computing necessary? Introduction to key cloud services (Compute, storage, networking) Cloud delivery models IaaS v/s PaaS v/s SaaS Introduction to cloud vendors(Azure,AWS, GCP) Key Cloud Security Principles Shared responsibility model Principle of least privilege Defense in depth Threat actors, diagrams & trust boundaries Practice : Create a cloud account Create 2 accounts Setup 2Factor Authentication on both account			3
	1,3, 4	2,3, 4	2	Cloud asset management	1		3	Identity & Access management in the cloud Introduction to IAM Introduction to Federal Identity Management IAM Best Practices			3

								IAM Audit Intro to AWS/Azure clint and Web Portal			
	3,4	2,3,4	3	Vulnerability management Discovering cloud misconfiguration Remediating vulnerabilities Tracking open vulnerabilities using cloud native tools	1		3	Network security Security groups VPC WAF	1		2
	3,4	2,3,4	4	Incident response - Log analysis - Events & alerts - Key metrics (MTTD & MTTR)	1		3	Data protection in the cloud • Data protection at rest and at transit • Cloud data storage - AWS EBS, S3 / Azure SAS • Secrets Management			3
			5	**CIE 3 – Written and Practice Test** **Secure a vulnerable cloud env**				Assessment Review and corrective action			3
	3,4	2,3,4	6	**Industrial class :** **1. Preventing DDoS in a cloud native env** **Hybrid cloud env**	2		3	Weekly Assignment			
8	1,3,4,5	2,3,4	1	Peer review Project status review		4		Intro to VAPT Developing a Hacker Mindset • Ethics of Penetration Testing • Goal of Penetration Testing • Thinking like a Hacker • ATT&CK Framework Overview • Introduction to the framework • Deep dive into the key topics	1		2

								○ Reconnaissance ○ Initial Access ○ Privilege Escalation ○ Lateral Movement ○ Exfiltration			
	1,3, 4,5	2,3, 4	2	Web Application Penetration Testing • Basics of Web ○ HTTP Methods ○ HTTP Requests & Response ○ Session management & Cookies			4	Web Application Penetration Testing • Finding common web vulnerabilities (OWASP top 10) • Burp Suite Essentials Practical:Setup Burp Suite on local machine and observe traffic of 1 website..			3
	1,3, 4,5	2,3, 4	3	Cloud Penetration Testing • Finding common cloud vulnerabilities • Introduction to tools: Nessus, NMAP, Prowler			4	Introduction to OSINT: • Scanning the internet (example: Shodan) • Google dorking • Subdomain enumeration & asset monitoring			3
	1,3, 4,5	2,3, 4	4	Hands-on exercise 1: Complete 3 server-side and 3 client-side topic from Burp Suite academy: https://portswigger.net/web-security/learning-path	1		3	Hands-on exercise 2: Complete either the attacker or defender track in http://flaws2.cloud	1		2
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	1,3, 4,5	2,3, 4	6	**Industrial class :** How penetration testing is used in companies to improve their Security posture				Weekly Assignment			

9	1,3, 4,5	2,3, 4	1	Peer review Project status review		4		Mobile Application Security Testing ○ Basics of Mobile Application ○ Introduction to Android Mobile OS ○ Understanding Android Security Architecture ○ Introduction to iOS Mobile OS ○ Understanding iOS Security Architecture	1		2
	1,3, 4,5	2,3, 4, 7	2	Understanding Android Application security • Reversing Android Application Package • Analysing Android Application Certificates and Signatures • Verifying Android Application Signatures • Analysing the Android Manifest file	1		3	Setting up the environment: • Installing Android Studio • Installing Geny Motion Emulator (Free) • Creating Android Virtual Devices • Using Android Debug Bridge (ADB) to interact with the Android Virtual Devices (AVD) • Transferring files between Host machine and AVD using ADB • Installing Android Applications onto AVD via ADB	1		2
	1,3, 4,5	2,3, 4, 7	3	Setup the following tools onto your machine and reverse the application on the DIVA Android application. - Apktool			4	Mobile Application Security Testing • Introduction to Mobile OWASP Top 10 • Burp Suite/OWASP Zap for Mobile Applications	1		2

				- Dex2Jar - JDGUI							
	1,3, 4,5	2,3, 4	4	Setting up for Android Application Security Testing Install DIVA Android Application (https://github.com/payatu/diva-android) ● Mobile Security Exploitation ● Exploiting Insecure Data Storage ● Exploiting Insecure Cryptographic Implementations ● Exploiting Data Leakage Vulnerabilities	1		3	Exercise: Setup MobSF locally on your system and scan any 5 Android Applications.	1		2
			5	**CIE 4 – Written and Practice Test**				Assessment Review and corrective action			3
	1,3, 4,5	2,3, 4	6	**Industrial class :** Bug bounty hunting				Weekly Assignment			

References :

1. **Basics of Web: https://www.hacker101.com/sessions/web_in_depth.html**
2. **NMAP Basics: https://www.freecodecamp.org/news/what-is-nmap-and-how-to-use-it-a-tutorial-for-the-greatest-scanning-tool-of-all-time/**
3. **HTTP Proxy:**
    a. **Burp Suite Essentials: https://www.youtube.com/playlist?list=PLoX0sUafNGbH9bmbIANk3D50FNUmuJIF3**
    b. **OWASP Zed Attack Proxy: https://www.zaproxy.org/getting-started/**
4. **Vulnerability Scanning with Nessus: https://www.tenable.com/blog/how-to-run-your-first-vulnerability-scan-with-nessus**

5. How to think like a Hacker: https://www.darkreading.com/vulnerabilities-threats/how-to-think-like-a-hacker **The Cuckoo's egg (book)**											
10	3,4	2,3, 4, 7	1	Peer review Project status review		4		Incident management introduction and objectives Stages and life cycle of incident management Tracking incidents Incident remediation Reporting and documentation Incident Closure Incident management teams and models Incident management services and integration tools - Best practices of Incident Management	1		2
	3,4	2,3, 4, 7	2	Fundamentals · CIA · Threat Actors · Different kinds of hackers · Different kinds of teams – Blue, Red, Purple · Criminal Groups · Hactivist Groups · APT · Attack Vectors · Protect/Prevent · Detect/Respond · Trust Positive vs False Positive Data · Bits and Bytes	1		3	Network · Quick revision of OSI model, encapsulation, IP, Subnets, TCP/UDP, well known ports, TCP/IP, Layer 2 Network Protocols · Quick revision of SMTP, HTTP, HTRPS/TLS, DNS Web technologies · Quick revision of DOM, CSS, Javascript, Ajax, MVC, Databases, SQL Authentical protocols	1		2

				· Charter Encoding (ASCII, UTF-8,Base64) · File Magic Bytes, Hashes · Imphash · Ssdeep Windows & Linux - · Quick revision on basic commands, important files and directories, windows registry and processes, Audit in Linux				· Quick revision of Kerberos, SAML, OpenID, OAuth			
	3,4	2,3, 4	3	Understanding the tools and products used in any organization · Firewall, load balancers, proxy, email infrastructure, IDS, DNS, Ani-virus, Content Delivery Solutions, Malware Protection System, Endpoint Detection and Response, Network Access Control, Placement of all devices in the organization – Tier1, Tier 2, Tier 3, DMZ	1		3	Continued..			3
	3,4	2,3, 4	4	SIEM · Understanding logs · Email, Proxy, DNS, IDS, Firewall, AV, EDR, Web application, Unix, Windows Attack Types/Vectors · Phishing, Malware, Distributed Denial of Service, Vulnerabilities (Infrastructure, Application, third party), Web attacks, Misconfigurations, Brute force	1		3	Basics of Incident Response · Alert processing · Procedures, runbooks and reference · Response options · Escalations · Incident categories · Incident Resolution Codes Data Analysis			3

				Attack Models · The cyber kill chain, MITRE ATT&CK Framework, Pyramid of Pain				· Data vs Intelligence · Indicators of compromise (IoCs) · Malware analysis · Accessing IoCs · Contacting threat intelligence Analysis tools · Anomaly · Domain tools · WhoIS · Passive DNS · Virus total · Dynamic File analysis			
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	3,4	2,3, 4, 7	6	**Industrial class :** Handling Internal and external incidents Complexity of Incident management Demo of real world SOC				Weekly Assignment			

References :

1. https://nvlpubs.nist.gov/nistpubs/specialpublications/nist.sp.800-61r2.pdf
2. https://www.cisa.gov/uscert/bsi/articles/best-practices/incident-management

https://www.infotech.com/research/ss/develop-and-implement-a-security-incident-management-program

Lab : https://letsdefend.io

11	3,4, 5	2,3, 4	1	Peer review Project status review		4		GRC (a) 1) Definition of GRC, introduction to IT governance (b) 2) Importance of GRC in cyber security (c) 3) Policies, processes and procedures (d) 4) Importance of checklists, templates and guidelines Enterprise risk management (a) Understanding risks that enterprises face – Operational Risks, Strategy Risks, Credit risks, Reputational risk, Market risks, Cyber risk (b) Cyber risk integration with Operational risk management	1		2
	3,4, 5	2,3, 4, 7	2	- <u>Introduction to basics of risk management</u> Probability, Impact:-- [Financial, Legal, Regulatory, Reputational], Threat, Risk Assessment, Risk Treatment:-- [Accept, Mitigate, Transfer, Avoid], Residual risk, risk acceptance, Control objective, Controls:-- Preventive control, detective control and corrective control	1		3	<u>Patch management</u> Importance of patch management; pre-requisites and sample patch management process <u>Vulnerability Management</u> Vulnerability management lifecycle understanding – Identify, Evaluate, Remediate, Report	1		2

								Types of vulnerabilities – Hardware, Network, Operating systems, Application, Human and Process related vulnerabilities Vulnerability Management process			
	3,4, 5	2,3, 4, 7	3	Practice Session: (a) Define one control statement each for access control, physical security and backup management (b) Explain one human vulnerability with example and how it can be exploited including remedial measures (c) Design IT asset register template with 5 sample rows populated with data Give examples for each category of classified information in an organization – do a combination of government organization and private organisation			4	ITIL Process overview – Incident Management, Problem Management, Change Management, Configuration Management, Release Management, Supplier Management, IT Security Management, Service level management, Capacity Management, Availability Management, Service continuity Management			3
			4	Security frameworks and Compliances			4	Cyber Security Governance:	1		2

				Introduction to standards/best practices/framework and its primary objective, ISO 27001, COBIT, PCI-DSS, Hi-Tech (HIPAA), NIST, IT Act 2000 (amendment in 2008), CERT-IN Guidelines. <u>Regulatory requirements</u> (a) RBI framework for banking (Cyber security framework, Gopalakrishna committee, UCB tiered framework) (b) SEBI framework for Securities market (c) Guidelines on Information and cyber security for insurers from IRDAI (d) TRAI requirements on security for telecom sector (e) GDPR				(a) Security organization, Responsibilities and authority, Management/Board responsibilities on cyber security, Resource allocation and cyber security budget management, Security Education, training and awareness, Cyber metrics, KRI/KPIs			
			5	**CIE 5 – Written and Practice Test**				Assessment Review and corrective action		3	

	3,4	2,3, 4,7	6	**Industrial class :** 1. An industry perspective of GRC, VM and Security frameworks Demo of a GRC tool				Weekly Assignment (Suggestive Student Activities) (a) Identify use case of how changes or configuration in IT systems impacts security configuration resulting in cyber risk exposure (b) Design a sample cyber security dashboard for reporting to top management (c) Give two KRI examples each for the following domains: a. Patch Management b. Anti-virus management c. Change Management			

References :

1) https://www.armosec.io/blog/kubernetes-security-frameworks-and-guidance - Security Frameworks table
2) https://www.cybersaint.io/blog/what-is-grc
3) https://www.ibm.com/cloud/learn/grc
4) https://unece.org/fileadmin/DAM/trade/Publications/WP6_ECE_TRADE_390.pdf
5) https://www.pcisecuritystandards.org/documents/PCI_DSS-QRG-v3_2_1.pdf

6) https://www.nist.gov/

7) https://www.isaca.org/resources/cobit

8) https://www.meity.gov.in/writereaddata/files/itact2000/it_amendment_act2008.pdf

9) https://www.coso.org/SitePages/Guidance-on-Enterprise-Risk-Management.aspx?web=1

10) https://rbidocs.rbi.org.in/rdocs/notification/PDFs/NT41893F697BC1D57443BB76AFC7AB56272EB.PDF

11) https://rbidocs.rbi.org.in/rdocs/notification/PDFs/LBS300411F.pdf

1) https://rbidocs.rbi.org.in/rdocs/notification/PDFs/NOTI129BB26DEA3F5C54198BF24774E1222E61A.PDF

14) https://www.sebi.gov.in/legal/circulars/dec-2018/cyber-security-and-cyber-resilience-framework-for-stock-brokers-depository-participants_41215.html

15) https://www.sebi.gov.in/sebiweb/home/HomeAction.do?doListing=yes&sid=1&ssid=6&smid=0

16) https://www.aicofindia.com/AICEng/General_Documents/Notices%20And%20Tenders/IRDAI-GUIDELINES.pdf

17) https://www.irdai.gov.in/ADMINCMS/cms/whatsNew_Layout.aspx?page=PageNo4315&flag=1

18) https://www.rapid7.com/fundamentals/patch-management/

19) https://www.rapid7.com/fundamentals/vulnerability-management-and-scanning/

1) 18. https://www.techtarget.com/searchsecurity/tip/IT-security-frameworks-and-standards-Choosing-the-right-one

21)https://www.irdai.gov.in/ADMINCMS/cms/Uploadedfiles/07.04.2017-Guidelines%20on%20Information%20and%20Cyber%20Security%20for%20insurers.pdf https://www.trai.gov.in/sites/default/files/RecommendationDataPrivacy16072018_0.pdf											
12	3,4, 5	2,3, 4	1	Peer review Project status review		4		DevOps and Security Challenges Understand the Core Principles and Patterns behind DevOps Recognize how DevOps works and identify keys to success	1		2
	3,4, 5	2,3, 4	2	Secure DevOps tools and workflows Conduct effective risk assessments and threat modeling in a rapidly changing environment Design and write automated security tests and checks in CI/CD Understand the strengths and weaknesses of different automated testing approaches in Continuous Delivery Inventory and patch your software dependencies Wire security scanning into Jenkins, Code Pipeline, and Azure DevOps workflows	1		3	Pre-Commit Security Controls Rapid Risk Assessment Git Hook Security Code Editor Extensions Branch Protections CodeOwners Peer Reviews Commit Security Controls Static Analysis Security Testing Component Analysis	1		2
	3,4, 5	2,3, 4	3	Secrets Management Managing secrets in CI / CD			4	Cloud Infrastructure as Code			3

				Azure Key Vault AWS SSM Parameter Store AWS Secrets Manager HashiCorp Vault				Introduction to Cloud Infrastructure as Code AWS Cloud Formation Terraform Deploying Cloud Infrastructure as Code security analysis			
	3,4, 5	2,3, 4	4	Configuration Management as Code Automating Configuration Management in CI / CD Using Ansible to Configure Virtual Machines Building Gold Images with Vagrant and Packer Certifying Gold Images with InSpec	1		3	Container Security Dockerfile and BuildKit Security Base Image Hardening with Hadolint and Conftest Container Image Security Scanning Container Images with Docker Scan and Trivy Container Registry Security Container Scanning with AWS ECR and Azure ACR Container Runtime Security Exercises Attacking the DevOps Toolchain Version Control Security Automating Static Analysis Protecting Secrets with Vault Infrastructure as Code Network Hardening Gold Image Creation Container Security Hardening	1		2

			5	**Developmental Assessment**				Assessment Review and corrective action				

Cloud Computing and Cyber Security

Under Prepration…….

Internet of Things (IoT)

Pre-requisites-

Knowledge of basic programming skills in python, networking concepts and basic electronic components

Course Outcomes-

Upon completion of the course, the student shall be able to

CO1	**Familiarize with Internet of Things Physical and Logical Design and Levels.**
CO2	**Understand IoT System Management with NETCONF-YANG**
CO3	**Understand Internet of Things, its hardware & software components and applications.**
CO4	**Interpret IoT Application Development**
CO5	**Discuss Security, Privacy and Governance in IoT**
CO6	**Explain IIoT and Case studies for IoT Design**

Course Contents

UNIT - 1: Introduction to Internet of Things

8 Periods

IoT – Definition, characteristics, Physical design of IoT, Things in IoT, IoT Protocols, Logical Design of IoT, IoT functional blocks, IoT communication Models, IoT communication API's IoT enabling Technologies – Wireless sensor networks, Cloud Computing, Big Data Analytics, Communication protocols, embedded systems. IoT Levels and Deployment templates – IoT Level-1, IoT Level-2, IoT Level-3, IoT Level-4, IoT Level-5, IoT Level-6, Popular IoT platforms, Domain specific IoTs

UNIT - 2: M2M, IoT System Management with NETCONF-YANG

6 Periods

M2M, Difference between IoT and M2M, SDN and NFV for IoT, Need for IoT Systems Management, Simple Network Management Protocol, Network Operator requirements, NETCONF, YANG, IoT Systems Management with NETCONG-YANG

UNIT - 3: Elements of IoT

8 Periods

Overview of IoT components-basic building blocks of IoT, Hardware Components- IoT Devices: Raspberry PI, Arduino; Sensors, Actuators, Smart objects and RFID, Software Components-Python Packages of interest for IoT, Networking Protocols

UNIT – 4: IoT Application Development

6 Periods

IoT Design Methodology, Linux on Raspberry PI, Raspberry PI interfaces, Programming Raspberry PI with Python, Data storage on cloud/local server

UNIT - 5: IoT Privacy, Security and Governance

6 Periods

Overview of Governance, Security and Privacy issues, Security, Privacy and Trust in IoT, IoT security life cycle, use of Blockchain in IoT security

UNIT - 6: IIoT and Case Studies on IoT Design

6 Periods

Industrial Internet of Things (IIoT), Differentiate IoT and IIoT, Case Studies-Home Automation, Urban Cities, Environment, Agriculture, Health Care, Transportation.

Reference Books

1. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547
2. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759
3. Dr. SRN Reddy, RachitThukral and Manasi Mishra, “Introduction to Internet of Things: A practical Approach”, ETI Labs
4. Raj Kamal, “Internet of Things: Architecture and Design”, McGraw Hill

Suggested E-learning referencess

1. https://internetofthingsagenda.techtarget.com/
2. https://dzone.com/iot-developer-tutorials-tools-news-reviews
3. https://blog.bosch-si.com/
4. https://www.hackster.io/
5. https://www.libelium.com/
6. https://www.ibm.com/blogs/internet-of-things/
7. https://azure.microsoft.com/en-us/blog/topics/internet-of-things/
8. https://blog.arduino.cc/
9. https://www.raspberrypi.org/blog/
10. www.lemalabs.com/iot

BLOCK CHAIN TECHNOLOGY

OBJECTIVES:

- To understand the concepts of block chain technology
- To understand the consensus and hyper ledger fabric in block chain technology.

OUTCOMES:

- State the basic concepts of block chain
- Paraphrase the list of consensus and Demonstrate and Interpret working of Hyper ledger Fabric
- Implement SDK composer tool and explain the Digital identity for government

UNIT - I

History: Digital Money to Distributed Ledgers -Design Primitives: Protocols, Security, Consensus, Permissions, Privacy- : Block chain Architecture and Design-Basic crypto primitives: Hash, Signature- Hash chain to Block chain-Basic consensus mechanisms.

UNIT - II

Requirements for the consensus protocols-Proof of Work (PoW)-Scalability aspects of Block chain consensus protocols**:** Permissioned Block chains-Design goals-Consensus protocols for Permissioned Block chains.

UNIT - III

Decomposing the consensus process-Hyper ledger fabric components-Chain code Design and Implementation: Hyper ledger Fabric II:-Beyond Chain code: fabric SDK and Front End-Hyper ledger composer tool.

UNIT - IV

Block chain in Financial Software and Systems (FSS): -Settlements, -KYC, -Capital markets-Insurance- Block chain in trade/supply chain: Provenance of goods, visibility, trade/supply chain finance, invoice management/discounting.

UNIT - V

Block chain for Government: Digital identity, land records and other kinds of record keeping between government entities, public distribution system / social welfare systems: Block chain Cryptography: Privacy and Security on Block chain.

TEXT BOOKS:

1. Mark Gates, "*Block chain: Ultimate guide to understanding block chain, bit coin, crypto currencies, smart contracts and the future of money*", Wise Fox Publishing and Mark Gates 2017.
2. Salman Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O'Dowd, Venkatraman Ramakrishna, "*Hands-On Block chain with Hyper ledger: Building decentralized applications with Hyperledger Fabric and Composer*", 2018.
3. Bahga, Vijay Madisetti, "*Block chain Applications: A Hands-On Approach*", Arshdeep Bahga, Vijay Madisetti publishers 2017.

REFERENCE BOOKS:

1. Andreas Antonopoulos, "*Mastering Bitcoin: Unlocking Digital Crypto currencies*", O'Reilly Media, Inc. 2014.
2. Melanie Swa, "*Block chain* ",O'Reilly Media 2014.

WEB REFERENCES:

- NPTEL & MOOC courses titled blockchain technology
- blockgeeks.comguide/what-is-block-chain-technology
- https://nptel.ac.in/courses/106105184/

DRONE TECHNOLOGY & ROBOTICS

COURSE OBJECTIVES

The course should enable the students to:

1. Learn concepts of Drone and Drone Technology
2. Impart knowledge of AI and Drone technology for various domains applications
3. To make the students to understand the basic concepts of UAV drone systems.
4. To introduce the stability and control of an aircraft

COURSE OUTCOMES

1. Design, build and program simple autonomous robots.
2. Implement standard signal processing and control algorithms.
3. Ability to design UAV drone system
4. To understand working of different types of engines and its area of applications
5. To understand static and dynamic stability dynamic instability and control concepts

UNIT-I- Robotics, Sensors and Signal processing Robotics:

Robotics and AI, Embedded Systems, Agent-Task-Environment model, Embodied Systems, Synthetic approaches to science Sensors and signal processing Common sensors and their properties, 1D signal processing, Vision

UNIT-II- AI and the Internet of Things:
AI and the Internet of Things: Real World Use-Cases: Automated vacuum cleaners, like that of the iRobot Roomba, Smart thermostat solutions, like that of Nest Labs

UNIT-III- Introduction to Drones:
Introduction to Drones: Introduction to Unmanned Aircraft Systems, History of UAV drones, classification of drones, System Composition, applications

UNIT-IV- Design of UAV Drone Systems:
Design of UAV Drone Systems: Introduction to Design and Selection of the System, Aerodynamics and Airframe Configurations, Characteristics of Aircraft Types, Design Standards and Regulatory Aspects-India Specific, Design for Stealth.

UNIT-V- Avionics Hardware of Drones:
Avionics Hardware of Drones: Autopilot, AGL-pressure sensors servos-accelerometer –gyros-actuators-power supply-processor, integration, installation, configuration.

TEXT BOOKS

1. Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010.
2. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc., 1998.

REFERENCE BOOKS

1. The Art of Robotics: An introduction to engineering, F Martin, Addison-Wesley, forthcoming

DATA ANALYTICS

I. RATIONALE

Data Analytics uses statistical and computational methods to analyze data, aiding informed decision-making. Excel dashboards effectively present vital data at a glance, enhancing user interactivity. A Data Analyst collects, cleans, and visualizes Datasets to solve problems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Perform Data Analytics in various business domains for improved decision making

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1 - Elaborate the fundamental concepts of Data Analytics.
CO2 - Apply appropriate statistical techniques to analyze and interpret complex Datasets.
CO3 - Analyze numerical data by creating pivot table.
CO4 - Represent data in terms of various types of charts.
CO5 - Visualize the data using a Python library.

IV. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Course Content	Hours
1	**Unit - I Introduction to Data Analytics** 1.1 Data Analytics: An Overview, Importance of Data Analytics 1.2 Types of Data Analytics: Descriptive Analysis, Diagnostic Analysis, Predictive Analysis, Prescriptive Analysis, Visual Analytics 1.3 Life cycle of Data Analytics, Quality and Quantity of data, Measurement 1.4 Data Types, Measure of central tendency, Measures of dispersion 1.5 Sampling Funnel, Central Limit Theorem, Confidence Interval, Sampling Variation	
2	**Unit - II Statistical Analysis** 2.1 Graphical techniques, box plot, skewness and kurtosis, Descriptive Stats 2.2 Correlation and Regression, Data Cleaning 2.3 Imputation Techniques 2.4 Anova and Chi Square 2.5 Scatter Diagram 2.6 Estimation and Hypothesis Testing 2.7 Sampling Distributions, Counting 2.8 Probability,Probability Distributions	

3	**Unit - III Data Analytics with Excel** 3.1 Excel Dashboard: Tables and Data Grids, Dynamic Filters and Controls, Trend Analysis and Forecasting 3.2 Pivot Tables: Creating a Pivot Table Specifying Pivot Table Data 3.3 Changing a Pivot Tables, Calculation Filtering and Sorting a Pivot Table 3.4 Creating a Pivot Chart, Grouping Items 3.5 Updating a Pivot Table, formatting a Pivot Table using Slicers	
4	**Unit - IV Data Visualization** 4.1 Creating a Simple Chart, Charting Non-Adjacent Cells 4.2 Creating a Chart Using the Chart Wizard, Modifying Charts, Moving an Embedded Chart, Sizing an Embedded Chart 4.3 Changing the Chart Type, Changing the Way Data is Displayed, Moving the Legend 4.4 Formatting Charts, Adding Chart Items, Formatting All Text, Formatting and Aligning Numbers, Formatting the Plot Area, Formatting Data Markers 4.5 Pie Charts, Creating a Pie Chart Moving the Pie Chart to its Own Sheet Adding Data Labels, Exploding 1.6 a Slice of a Pie Chart	
5	**Unit - V Data Visualization using Python** 5.1 Overview of Matplotlib and its role in data visualization, Installing and setting up Matplotlib in Python 5.2 Basic plotting with Matplotlib, Line plot, Scatter plots, Bar charts, Histograms, adding titles, labels, and legends to plots 5.3 Changing figure size and aspect ratio, Customizing axes (limits, ticks, and labels) 5.4 Exporting and Saving Visualizations: Saving plots in different formats (PNG, PDF, SVG), Adjusting the resolution and quality of saved plots, creating interactive visualizations using Matplotlib widgets	

SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	**Jinjer Simon**	**Excel Data Analysis: Your visual blueprint for analyzing data, charts, and PivotTables**	**Wiley Publication Edition: 3rd ISBN: 978- 0-470-59160-4**
2	**A. J. Smalley**	**Data Analysis with Excel**	**SAGE Publications Edition: 1st, 2007 ISBN 10: 0070139903 / ISBN 13: 9780070139909**
3	**Fabio Nelli**	**Python Data Analytics: With Pandas, NumPy, and Matplotlib**	**Apress pubication ISBN-13 :978-1484239124 ISBN-13978-1484247372**
4	**Jake VanderPlas**	**Python Data Science Handbook**	**Shroff/O'Reilly Publication ISBN-10-9355422555 ISBN-13-978-9355422552**

5	Business Analytics with MindTap	Jeffrey D. Camm | James J Cochran | Michael J. Fry | Jeffrey W. Ohlmann	Cengage Learning India Pvt. Ltd. Publication Edition:4th ISBN: 9789360533533

V. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://spreadsheetpoint.com/excel/dashboard-in-excel/	Advance Excel
2	https://www.javatpoint.com/how-to-create-a-dashboard-in-exce l	Excel Dashboard
3	https://www.simplilearn.com/tutorials/excel-tutorial/data-an alysis-excel	Data Visualization
4	https://www.freecodecamp.org/news/introduction-to-data-vizua lization-using-matplotlib/	Matplotlib in Python
5	https://archive.nptel.ac.in/courses/106/107/106107220/	Introduction to data analytics

AUTOMATION & ROBOTICS

Course Code- **(3-0-0)**

Introduction:

Welcome to the curriculum for the Specialization Pathway – **Automation and Robotics**. This specialization course is taught in Boot camp mode. Boot camps are 12 weeks, intense learning sessions designed to prepare you for the practical world – ready for either industry or becoming an entrepreneur.

Manufacturing industries are moving towards complete automation, also using robots to perform most of the operations. Industrial automation systems are used to control and monitor a process, machine or device in a computerized manner that usually fulfills repetitive functions or tasks. They are intended to operate automatically and systematically in order to reduce and improve human work in the industry. Automotive industries are switching to PLC technology for data acquisition and control. Industrial automation systems are used to control and monitor a process, machine or device in a computerized manner that usually fulfills repetitive functions or tasks. This course attempts to provide basic theoretical and practical aspects of automation technologies to develop operational competency, also gives knowledge on robotics. Hence this course is the foundation for diploma engineers who want to further specialize in the field of industrial automation and robotics.

You will be assisted through the course, with development-based assessments to enable progressive learning. In this course, you'll learn how to automate different activities in various applications and also incorporate Robots for required activities in an automation system.

Leading to the successful completion of this boot camp, you shall be equipped to either do an **Internship** in an organization working on **Automation and Robotics** or take up a **Project** in the related field. After the completion of your Diploma, you shall be ready to take up roles like Automation Engineer, Floor shop Manager, Production In-charge and also can become Entrepreneur in the related field and more.

Pre-requisite

Before the start of this specialization course, you will have prerequisite knowledge gained in the first two years on the following subjects

1st year -Engineering Mathematics, Communication Skills, Computer Aided Engineering Drawing, Statistics & Analysis, Basic IT Skills, Fundamentals of Electrical and Electronics Engineering, Project Management skills, Mechanical Science & Engineering and Automotive Engines.

2nd year-Automobile Chassis and Transmission System, Automotive Electrical System, Thermal Engineering and Engine Testing, Automotive Manufacturing Processes, Advanced Automotive Systems, Design and Drafting, Vehicle Body Engineering and Dynamics and Fuel and Pollution Control. In this year of study, you

shall be applying your previous years learning along with specialised field of study into projects and real-world applications.

Course outcome: A student should be able to

CO1	Select the right sensor and/or actuator for automating a given application and demonstrate process variables using sensors and/or transducers.
CO2	Perform specified control functions using a Programmable Logic Controller (PLC) and list various applications of embedded systems
CO3	Design and test an automation system for a required operational specification and troubleshoot to resolve any given issue
CO4	Identify the possibilities of automation in a production system
CO5	Develop, simulate, interface and Execute Robot Program for a specified process

Course Content

About Specialization – Future-Companies and Service sectors in India and outside India, Career opportunities. Importance and scope of automation & robotics in automobile industry.

About Automation & robotics- History- Importance- with an Example of a company (like Toyota, M&M, Volvo etc….) brief how/why the need for automation and use of robots evolved in automobile industry.

Detailed course plan

(Week 1):

Week	CO	PO	Days	1st session (9am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
1			1	About Specialization – Future-Companies and Service sectors in India and outside India, Career opportunities. Importance and scope of automation & robotics in automobile industry.	2		2	About Automation & robotics- History- Importance- with an Example of a company (like Toyota, M&M, Volvo etc….) brief how/why the need for automation and use of robots evolved in automobile industry.	3		
1	1	1		Introduction: 1. Need and benefits of Industrial Automation, Automation Hierarchy, Basic components of automation system, description of each component. 2. Automation technology as a part of engineering sciences, Key development milestones in the history of automation technology, Effects of automation on people. 3. Types of automation system :-Relay logic and PLC.	4			*Study the following appliances/ automation systems and identify various elements used and their function in: automotive Air conditioning System/ autonomous car/ any automation related to automotive industry.*			3
	1	1	3	Programmable logic controller: 1. Introduction, Compare Relay Logic Control and PLC Logic Control, Internal Architecture of PLC	4			Input devices: • Mechanical Switches • Proximity Switches	3		

				2. I/O Modules (Interfaces), Memory organization.				2. Input devices: • Photo electric Sensors and Switches • Encoders • Temperature Sensors • Position/Displacement Sensors				
	1	1	4	*Demonstrate the working of below shown switches / Sensor.* *a. Various industrial Switches (Push Button, ON/OFF, Toggle, Emergency, Rotary Switches etc.)* *b. Proximity- Inductive, Capacitive and Optical Sensor* ***Note: Connect each sensor directly to the LED/Lamp with appropriate power supply***			4	*Demonstrate the working of below shown switches / Sensor.* *a. Temperature Sensor* *b. Float Sensors* ***Note: Connect each sensor directly to the LED/Lamp with appropriate power supply***			3
			5	**Developmental Assessment**				Assessment Review and corrective action			3
			6	**Industrial Class + Industrial Assignment** **Industry Class on:** Arrange a talk from need for Industrial Automation and Programmable logic controller	2		3				
(Week 2):												

2	1	1	1	Tutorial (Peer discussion on Industrial assignment)	-	4	-	1. Input devices: • Strain Gauges • Pressure Sensors • Liquid level detectors 2. Input devices: • Fluid flow measurement • Smart Sensors 3. Output Devices: • Relay • Directional control Valve	2	1	
	1	1	2	1. ADC and DAC 2.Motors- DC motor, Synchronous motor, Servo motor, 3.Induction motor, Stepper motor	4			*Demonstrate the Forward and Reversal of Stepper,* *Servo and DC Motors with the help of Drivers.* ***Note: Demonstrate the above without using any controllers***	1		2
	2	2	3	PLC Programming: 1. Programming standards, List Different PLC Programming, Ladder diagram, 2. Standard IEC 1131-3 Symbols used for I/O Devices 3. Ladder diagram for logic gates. AND, OR, NOT, NAND, NOR, XOR, XNOR	2	2		Write the ladder diagrams for different applications Ex: A system where there has to be no output when any one of four sensors gives an output, otherwise there is to be an output			3
	2	2	4	*Write ladder diagram to test digital logic gates and* *Execute/Simulate the same.*			4	1. *Writing Equivalent ladder diagram for Electric Switch, Belt drive, motor circuit Latching, Sequential O/P*			3
			5	**Developmental Assessment**				Assessment Review and corrective action			3

			6	Industry Class on selection parameters of PLC for a given application	2		2	Industry Weekly Assignment(1PM-2PM)				1
(Week 3):												
3	2	1	1	Tutorial (Peer discussion on Industrial assignment)		4		Introduction to Timer functions. Applications of timing functions in process control - - On Delay Timer Function, Off-delay Timer Function	3			
	2	1	2	PLC counter functions, Applications of PLC counter function in process control	2	2		Write a Ladder Program to count the number of Items moving on a conveyor Belt and Execute/Simulate the same				3
	3	2	3	Develop a PLC ladder diagram to construct an alarm system which operates as follows. - If one input is ON nothing happens. - If any two inputs are ON, a red light goes ON. - If any three inputs are ON, an alarm sirens sound. - If all are ON, the relevant department is notified.			4	Simulate the PLC ladder diagram developed for an alarm system and also Demonstrate by interfacing with PLC	3			
	3	2	4	Develop automatic door system using optical sensor and linear actuator			4	Execute automatic door system using optical sensor and linear actuator				3
			5	**CIE 1 – Written and Practice Test**				Assessment Review and corrective action				3
			6	**Industrial Class + Industrial Assignment** Industry Class on prevailing PLC Simulation software's and its merits and demerits	2		3					
(Week 4):												
4	3	2	1	Tutorial (Peer discussion on Industrial Visit), Report submission on visit.		4		*Design ladder diagram for car parking.* (Hint: car is to be detected and enter the parking space				3

								to a particular location if space is available. If there is no space, a lamp should indicate that parking is full)				
	2	3	2	*Simulate a ladder diagram for car parking.*			4	*Design ladder diagram for operating and controlling the Lift.*				3
	2, 4	2, 7	3	*Write a ladder diagram and simulate a circuit for a process control application in which a paint spray has to run for 40 seconds when the count reaches the value of 25.*			4	Embedded System- Block Diagram of Embedded System	3			
	2, 4	2, 7	4	2)Applications of Embedded System • Robotics Drones • Braking System • Air conditioning, Refrigerator • Engine control System	3		1	Applications of Embedded System • Keyless entry in Automobiles. You tube Presentation on Applications of Embedded System	1			2
			5	**Developmental Assessment**				Assessment Review and corrective action				3
	2		6	**Industrial Class + Industrial Assignment** Industry Class on prevailing PLC Simulation software's and its merits and demerits	2		3					
(Week 5):												
5	4	1	1	Tutorial (Peer discussion on Industrial assignment)		4		Demonstrate the selection criteria, specification and Application: of Optical (Photoelectric) Sensors, Capacitive proximity sensors, Inductive proximity Sensors, optical proximity sensors, Pressure sensors, Resistive Temperature Detectors (RTDs), Thermocouples, Thermistors, Light Dependant Resistors (LDR) (Refer manufacturer's catalogue)				3

	4	1	2	Select a suitable type of sensor used to recognize the Presence or absence of an object as they pass along a conveyor. Explain your choice and then draw a wiring diagram that shows how it will be wired to an appropriate PLC			4	Explain the importance of Flexible Manufacturing systems Explain the types of FMS • Single-machine cell • Flexible Manufacturing Cell • Flexible Manufacturing system • Dedicated FMS • Random Order FMS	3		
	4	1	3	Explain the Components of FMS • Work stations • Material Handling and Storage System • Computer control system Explain the FMS Layout Configuration • Inline Layout • Loop Layout • Open Field Layout • Robot Centered Cell	4			**You Tube Videos on FMS Systems + Discussion+ Report Writing**				3
	4	1	4	Explain an Overview on • AGV Guided Technology • AGV Management • AGV Safety Systems **You Tube Videos on AGVs**	2		2	Explain an Overview on • Automated storage/Retrieval systems • Components of AS/RS 1. Storage structure 2. S/R machine 3. storage modules (e.g., pallets for unit loads) 4. Pickup-and-deposit stations		1	2
			5	**CIE 2 – Written and Practice Test**				Assessment Review and corrective action			3
	4		6	**Industrial Class + Industrial Assignment** Industry Class on communication protocols in automation	2		3				
(Week 6):											

6	5	1	1	Tutorial (Peer discussion on Industrial assignment)		4		Virtual tour on industrial Application of a Robot			3
	5	1, 2, 4	2	1.INTRODUCTION-Robotics, Industrial robot 2.Automation and robotics: Types of Automation 3.Reasons for implementation of automated systems in manufacture industries, need for using robotics in industries. 4.CAD/CAM & Robotics, Specifications of robotics	4			Explain the overview of Robots & Its Importance in Production system 1. Types of robots: Manipulators, Mobile robots- Wheeled & legged robots, Aerial robots. 2. Basic components of Robots: Base, Link & joint, Wrist, End effector, Actuator, sensor, Controller.	3		
	5	1, 2, 4	3	1. Configurations of robots – Articulated Robot, Polar configuration, SCARA, Cartesian Co-ordinate Robot, Delta Robot. 2. Wrist configuration 3. Work Volume 4. Degree of Freedom- Forward and Back, Up and Down, Left and Right, Pitch, Yaw, Roll	4			1. Joint Notation & Type of joints in robot- Linear Joint (L Joint), Orthogonal Joint (O Joint), Rotational Joint (R Joint), Twisting Joint (T Joint), Revolving Joint (V Joint) 2. Types of sensors used in industrial robot & their application- Tactile Sensor, Proximity Sensors, Optical Sensors, Other Sensors (Temperature, Pressure, Voltage, Current, Acoustics sensors etc.)	3		
	5	1, 2, 4	4	1. End Effectors- Grippers, Tools 2. Types of grippers 3. Factors to be considered for selecting a Gripper 4. Robotic Drives- Electric Drive, Pneumatic Drive, Hydraulic Drive	2		2	Explain the Robot Control systems- • Point- to Point control Systems • Continuous Path Control • Intelligent control	1		2
	5		5	**Developmental Assessment**				Assessment Review and corrective action			3
	5		6	**Industrial Class + Industrial Assignment** Industry Class on smart manufacturing	2		3				

(Week 7):											
7	5	1, 2, 4	1	Tutorial (Peer discussion on Industrial assignment)		4		**Present a Robotic Coordinate system using a robot** • Joint co-ordinate system • Rectangular co-ordinate system • User or object coordinate system • Tool coordinate system. **Steps to define user co-ordinate system.** • Defining X, Y, Z co-ordinate system • Verifying co-ordinate system by multiple motion movements.	1		2
	5	1, 2, 4	2	Present an overview of the Robotic Cell • Identify the Robotic Cell Components & Application tools			4	**Perform Mechanical Installation check of robot** • Checking of proper installation of the safety sensors • Checking of Physical grouting of robot and other peripheral devices (cable trays, fences, fixtures, electric boxes etc.).			3
	5	2, 4	3	**Perform Electrical Installation check of robot** • Checking of the electric connections- Earthing cable, power cable, Pneumatic pipes etc	2		2	**Powering on the Robot and making the cell Healthy for programming** • Turning in the main supply to robot, turn on the stabilizers, Robot Controller. • Check the pneumatic clamps in fixtures, Grippers on robots. • Starting Up and Shutdown Steps in Robot • Check the Booting of the teach pendant			3

	5	1, 2, 4	4	**Demonstrate and practice Robot Programming Methods** • **Teach pendant Programming** • **Programming by using Languages** • **Offline Programming and Simulations**			4	**Demonstrate and practice Robot Programming Methods** • **Teach pendant Programming** • **Programming by using Languages** • **Offline Programming and Simulations**			3
	5		5	**CIE 3 – Written and Practice Test**				Assessment Review and corrective action			3
	5	1, 2, 4	6	**Industrial Class + Industrial Assignment** Industry Class on Robotic Programing + Industry Assignment	2		3				
(Week 8):											
8	5	2, 4	1	Tutorial (Peer discussion on Industrial assignment)		4		**Able to work with Teach Pendant key functions & user interface for teach pedant** • Run Teach mode: Play mode, Remote mode • Run Steps to define Tool co-ordinate system: • Run TCP (Tool center point definition).	3		
	5	2, 4	2	**Able to work with Teach Pendant key functions & user interface for teach pedant** • Tool/ work object definition and their calibration • Creating user defined work objects • Create Box, circle, triangle work object definition • Multi-mode selection in virtual programming pendant			4	**Demonstration and practice of existing program & execution techniques** • Understanding Robot Program Structure. • Different Motion Types used in Programming (PTP, Linear, Circular, Spline) Via Point and Process Points.			3

	5	2, 4	3	**Demonstration and practice of existing program & execution techniques** Understanding Different Motion Parameters used in Program Point Recording			4	• **Identify the program motion command movements** • **Practice on Teach table or fixture for all move commands**			3
	5	2, 4	4	**1. Identify the program motion command movements** **2. Practice on Teach table or fixture for all move commands**			4	**1. Identify the program motion command movements** **2. Practice on Teach table or fixture for all move commands**			3
	5		5	**Developmental Assessment**				Assessment Review and corrective action			3
	5	2, 4	6	**Industrial Class + Industrial Assignment** Industry Class on Robotic Programing + Industry Assignment	2		3				
(Week 9):											
9	5	2, 4	1	Tutorial (Peer discussion on Industrial assignment) & Report Submission on mines visit.		4		**Demonstrate and practice the Pick & Place Application commands used in material handling and its Parameters settings**			3
	5	2, 4	2	**Create a robot program for pick & place by using move commands**	1		3	**Create a robot program for pick & place by using move commands**			3
	5	2, 4	3	**Explain and Present the Arc Welding Application commands used in welding and also, weld Parameter's settings**			4	**Create a robot program for welding application**			3
	5	2, 4	4	**Create a Robot program for welding application**			4	**Create a Robot program for welding application**			3
	5		5	**CIE 4 – Written and Practice Test**				Assessment Review and corrective action			3

	5	2, 4	6	**Industrial Class + Industrial Assignment** Industry Class on interfacing of Robots with peripheral devices	2		3					
(Week 10):												
10	5	2, 4	1	Tutorial (Peer discussion on Industrial assignment)		4		**Simulate a welding program with the help of simulation software & compare the tool path with manual program**	1		2
	5	2, 4	2	**Simulate a welding program with the help of simulation software & compare the tool path with manual program**	2		2	**Simulate a welding program with the help of simulation software & compare the tool path with manual program**			3
	5	2, 4	3	**Execution of Welding process by using Robot** • Selection of Welding tool for robot • Assembling of welding torch to manipulator.			4	**Execution of Welding process by using Robot** • Identify the PLC and robot communication for communicate with HMI. • Build the conveyor system and its communication with PLC.			3
	5	2, 4	4	**Execution of Welding process by using Robot** • Selection of welding source programming file • Adjust the Voltage and Amps rating Start ending and main conditions • Identify architecture of welding robot system • Power source connection with robot controller.			4	**Execution of Welding process by using Robot** • Working using ARCON, ARCOFF. Working using WEAVON, WEAVOFF • Practical welding demonstration • Quality check of welding and improvement with changing weld parameters			3

	5		5	**Developmental Assessment**				Assessment Review and corrective action			3
	5	2, 4	6	**Industrial Class + Industrial Assignment** Industry Class on prevailing Robot simulation software's	2		3				
(Week 11):											
11	5	2, 4	1	Tutorial (Peer discussion on Industrial assignment)		4		**Execution of Welding process by using Robot** • Practical welding demonstration • Quality check of welding and improvement with changing weld parameters			3
	5	2, 4	2	**Execution of Welding process by using Robot** • Practical welding demonstration • Quality check of welding and improvement with changing weld parameters			**4**	**Simulate a Pick & Place program with the help of simulation software & compare the tool path with manual program**			**3**
	5	2, 4	3	**Simulate a Pick & Place program with the help of simulation software & compare the tool path with manual program**			**4**	**Simulate a Pick & Place program with the help of simulation software & compare the tool path with manual program**			**3**
	5	2, 4	4	**Execution of Pick & Place process by using Robot** • Mounting the suitable Gripper on Robot Flange • List out gripper application in robot program & develop machine setting to assign the operation			**4**	**Execution of Pick & Place process by using Robot** • Identify the basic Pick & Place Program structure in robot with the help of teach pendant • Creating a program of pick and place with the help of gripper.			**3**

				• Interfacing Grippers to Robot using robot I/O • Interfacing Grippers to Robot using PLC I/O				• Understanding HAND INSTRUCTIONS in Robot • Understanding HANDLING WINDOW in Robot • Low Air Pressure Interlock • Creating the program with gripper application Practice for program creation with gripper application			
	5		5	Weekly Assessment **CIE 5 – Written and Practice Test**				Assessment Review and corrective action			3
	5	2, 4	6	**Industrial Class + Industrial Assignment** Industry Class on prevailing Robot simulation software's	2		3				
(Week 12):											
12	5	2, 4	1	Tutorial (Peer discussion on Industrial Visit) & report submission on Industry visit		4		• **Creating the program with gripper application** • **Practice for program creation with gripper application**			3
	5	2, 4	2	• **Creating the program with gripper application** • **Practice for program creation with gripper application**			4	**Simulate a spray-painting program with the help of simulation software & compare the tool path with manual program**	1		2
	5	2, 4	3	**Simulate a spray-painting program with the help of simulation software & compare the tool path with manual program**	2	2		**Execution of spray-painting process by using Robot** • Mounting the suitable Gripper on Robot Flange			3

								• List out gripper application in robot program & develop machine setting to assign the operation			
	5	2, 4	4	**Execution of spray-painting process by using Robot** • Identify the basic spray-paint Program structure in robot with the help of teach pendant • Creating a program to spray-paint with the help of gripper. • Understanding HAND INSTRUCTIONS in Robot • Understanding HANDLING WINDOW in Robot			4	**Execution of spray-painting process by using Robot** • Identify the basic spray-paint Program structure in robot with the help of teach pendant • Creating a program of spray-paint with the help of gripper.			3
	5		5	**Developmental Assessment**				Assessment Review and corrective action			3
	5	2, 4	6	**Industrial Class + Industrial Assignment** Industry Class on prevailing Robot simulation software's	2		3				
(Week 13): **Student can choose either Internship/ Project**											
13		2, 3, 4, 6		**Internship** **a) Secondary research on various industries and their operations to identify at least 3 companies along with the areas of work interest and develop an internship plan that clearly highlights expectations from the industry during the internship.** **b) Design and develop a cover letter for an internship request to all 3 identified companies and the resume to be submitted to potential companies.**				**Project:** **a) Identification of the problem statement (from at least 3 known problems) the students would like to work as part of the project – either as provided by faculty or as identified by the student. Document the impact the project**			40Hrs

				c) Prepare for an internship interview to highlight your interests, areas of study, career aspirations and personnel competence – including the areas of learning you expect to learn during internship.	**will have from a technical, social and business perspective.** **b) Design and develop the project solution or methodology to be used to solve at least one of the problems identified.** **c) Prepare a project plan that will include a schedule, WBS, Budget and known risks along with strategies to mitigate them to ensure the project achieves the desired outcome.**	

References

Sl. No	Description
1	Programmable logic Controllers By W. BOLTON
2	Digital electronics By FLYOD
3	Automation , Production systems and Computer integrated Manufacturing By MIKELL GROOVER
4	Sensors Hand book-SABRIE SOLOMAN-MC-GRAW HILL publications
5	Electric Motors and Drives BY AUSTIN HUGHES and BILL DRURY
6	Exploring PLC with applications By PRADEEP KUMAR SRIVATSAVA
7	Hand book of Modern Sensors" Physics , Designs and Applications- JACOB FRADEN-Springer Publications
8	Automating Manufacturing Systems with PLC by Hugh Jack
9	Thomas Braunl, Embedded Robotics: Mobile Robot Design and Application with Embedded Systems, 2nd ed., Springer, 2006.
10	John M. Holland, Designing Autonomous Mobil Robots: Inside the Mind of an Intelligent Machine, Newnes, 2003.
11	Industrial Robotics technology, programming and Application by Mikelle P Groover
12	Springer Handbook of Automation by Shimon Y. N

EMBEDDED SYSTEM WITH ARDUINO

Under Preparation……..

INDUSTRIAL & POWER ELECTRONICS LAB

Course Code- **L:T:P**

Pre-requisities:

This course requires the basic knowledge of Industrial & Power Electronics

Course Outcomes

On completion of the course, the student should be able to;

CO1	Analyze characteristics of various power electronic devices
CO2	Illustrate various power control methods and UJT relaxation oscillator
CO3	Analyze characteristics of various types of transducers.

Content-

1. Identify and test using DMM the Power Semiconductor devices SCR, TRIAC, DIAC,, SUS SBS
2. Identify and test using DMM MOSFET, IGBT, LASCR, UJT, OPTO COUPLERS MCT2E, MOC 3011
3. Plot the characteristics of MOSFET and determine gate source threshold voltage
4. Plot the characteristics of SCR and determine Triggering current
5. Plot the characteristics and determine the intrinsic standoff ratio of UJT
6. Construct UJT Relaxation oscillator circuit and observe the output waveforms on CRO
7. Trigger the SCR by UJT and control output Power
8. Plot the characteristics of TRIAC and DIAC
9. Verify that TRIAC can be triggered by positive and negative pulses
10. Implement 100 watt 230V AC Lamp Control circuit using Opto coupler MOC3011 and4 Amps TRIAC.
11. Draw the performance characteristics of LVDT

12. Draw the performance characteristics of RTD

13. Measure the temperature using IC LM 335

14. Implement an ON/OFF temperature controller using IC LM335 Draw the characteristics of Load cell

Suggested E-learning references

1. http://nptel.ac.in
2. https://www.youtube.com

IIOT WITH ARDUINO LAB

Prerequisites: This course requires a basic understanding of Ardiuno, electronics, Sensors and the concepts of programming using C.

Course Outcomes: Upon completion of the course, the student shall be able to

CO	Course Outcome
CO1:	Develop basic Arduino programs
CO2:	Interface Sensors, actuators and displays to Arduino
CO3:	Develop IOT applications using Arduino

Recommended books

1. Arduino-Based Embedded Systems : By Rajesh Singh, Anita Gehlot, Bhupendra Singh, and Sushabhan Choudhury.
2. Getting Started with Arduino, Book by Massimo Banzi
3. Arduino Made Simple by Ashwin Pajankar
4. Embedded C, Pont, Michael J

Suggested e-learning resources

1. https://projecthub.arduino.cc/
2. https://docs.arduino.cc/
3. https://hackr.io/tutorials/learn-arduino
4. https://www.instructables.com/Arduino-Projects/
5. www.nptel.ac.in
6. https://www.tinkercad.com/projects/Basics-of-Arduino-TINKERCAD

Learning Outcomes:
Upon completion of the course, the student shall be able to:

1. Download and install Latest Arduino IDE
2. Connect an LED to pin 13 and write a sketch to blink it.
3. Connect multiple LEDs to different pins and make them blink alternately.
4. Use PWM to vary LED brightness.
5. Use a push button to toggle an LED.
6. Use an LDR to control LED brightness based on ambient light.
7. Make a buzzer beep at different frequencies.
8. Control the position of a servo motor using Arduino.
9. Connect a TMP36 temperature sensor and display temperature readings.
10. Ultrasonic Distance Measurement: Measure distance using an HC-SR04 ultrasonic sensor.
11. Use a microphone or piezo sensor to detect sound and trigger an LED response
12. Display messages on a 16x2 LCD.
13. Simulate a traffic light using LEDs and control the sequence with code
14. Control the speed and direction of a motor using an L293D motor driver.
15. Serial Communication with Arduino: Send and receive data between Arduino and computer via serial communication.
16. Connect your Arduino to the internet and send sensor data to a cloud platform.

Suggested student Activities:

1. Design simple project using Arduino for your institute.
2. Design a simple project using Arduino for your home.
3. Design automatic college bell using Arduino for your institute.
4. Design a simple android app using MIT app inventor.
5. List advantages and disadvantages of advanced microcontroller boards like RaberryPI, BeagleBone, NodeMCU, Jestson etc., available in the market.