Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

Proposed scheme for Honors in Artificial Intelligence and Machine Learning

Sr.	Course Code	Course	Teaching Scheme (hrs.)				Continuous Assessment (A) (marks)			Semester End Assessment (B) (marks)					(A+B)	Total Credits
			Th	P	T	Credits	Th	T/W	Total CA (A)	Th / Cb	O	P	O & P	Total SEA (B)		
SEM V																
1	DJS22ECHN1C1	Mathematics and Statistics for Artificial Intelligence & Machine Learning	4	--	--	4	35	--	35	65	--	--	--	65	100	**4**
SEM VI																
2	DJS22ECHN1C2	Concepts and Algorithms in Artificial Intelligence & Machine Learning	4	--	--	4	35	--	35	65	--	--	--	65	100	**4**
3	DJS22ECHN1L1	Concepts and Algorithm in Artificial Intelligence & Machine Learning Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	**1**
SEM VII																
4	DJS22ECHN1C3	Deep Learning	4	--	--	4	35	--	35	65	--	--	--	65	100	**4**
5	DJS22ECHN1L2	Deep Learning Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	**1**
SEM VIII																
6	DJS22ECHN1C4	Pattern Recognition & Machine Learning	4	--	--	4	35	--	35	65	--	--	--	65	100	**4**
		Total	**16**	**4**	**0**	**18**	**140**	**50**	**190**	**260**	**0**	**0**	**0**	**260**	**450**	**18**

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Proposed scheme for Honors in Intelligent Connectivity: 5G & IoT

Sr. No.	Course Code	Course	Teaching Scheme (hrs.)				Continuous Assessment (A) (marks)			Semester End Assessment (B) (marks)					(A+B)	Total Credits
			Th	P	T	Credits	Th	T/W	Total CA (A)	Th / Cb	O	P	O & P	Total SEA (B)		
SEM V																
1	DJS22ECHN2C1	Sensor and Actuator Technology for IoT	4	--	--	4	35	--	35	65	--	--	--	65	100	**4**
SEM VI																
2	DJS22ECHN2C2	IoT System Design	4	--	--	4	35	--	35	65	--	--	--	65	100	**4**
3	DJS22ECHN2L1	Real Time System Design Laboratory	--	2	--	1	--	25	25	--	--	--	25	25	50	**1**
SEM VII																
4	DJS22ECHN2C3	Intelligent IoT Systems	4	--	--	4	35	--	35	65	--	--	--	65	100	**4**
5	DJS22ECHN2L2	Intelligent IoT Systems Laboratory	--	2	--	1	--	25	25	--	25	--	--	25	50	**1**
SEM VIII																
6	DJS22ECHN2C4	Fifth Generation Technology	4	--	--	4	35	--	35	65	--	--	--	65	100	**4**
		Total	**16**	**4**	**0**	**18**	**140**	**50**	**190**	**260**	**25**	**0**	**25**	**310**	**500**	**18**

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Proposed scheme for Minor in IoT and Industry 4.0

Sr.	Course Code	Course	Teaching Scheme (hrs.)				Continuous Assessment (A) (marks)			Semester End Assessment (B) (marks)					(A+B)	Total Credits
			Th	P	T	Credits	Th	T/W	Total CA (A)	Th / Cb	O	P	O & P	Total SEA (B)		
SEM V																
1	DJS22MN8C1	Sensor Technology	4	--	--	4	35	--	35	65	--	--	--	65	100	**4**
SEM VI																
2	DJS22MN8C2	IoT System Design	4	--	--	4	35	--	35	65	--	--	--	65	100	**4**
SEM VII																
3	DJS22MN8C3	IoT Network Design	4	--	--	4	35	--	35	65	--	--	--	65	100	**4**
4	DJS22MN8L1	IoT System and Network Design Laboratory	--	2	--	1	--	25	25	--	25	--	--	25	50	**1**
SEM VIII																
5	DJS22MN8C4	Industry 4.0	4	--	--	4	35	--	35	65	--	--	--	65	100	**4**
6	DJS22MN8L2	Industry 4.0 Laboratory	--	2	--	1	--	25	25	--	25	--	--	25	50	**1**
		Total	**16**	**4**	**0**	**18**	**140**	**50**	**190**	**260**	**50**	**0**	**0**	**310**	**500**	**18**

Honors in Artificial Intelligence & Machine Learning	**Semester: V**
Program: Electronics and Telecommunication Engineering	
Course: Mathematics and Statistics for Artificial Intelligence & Machine Learning (DJS22ECHN1C1)	

Pre-requisite: --

1. Engineering Mathematics – IV

Objectives:

1. To build an intuitive understanding of Mathematics and relating it to Artificial Intelligence, Machine Learning.
2. To provide a strong foundation for probabilistic and statistical analysis mostly used in varied applications in Engineering.
3. To explore optimization and dimensionality reduction techniques.

Outcomes: On completion of the course, the learner will be able to:

1. Apply linear algebra concepts to model, solve, and analyze real-world problems.
2. Apply probability distributions and sampling distributions to
3. Analyze various optimization techniques.
4. Describe Dimension Reduction Algorithms

Mathematics and Statistics for Artificial Intelligence & Machine Learning (DJS22ECHN1C1)		
Unit	**Description**	**Duration**
1	**Linear Algebra**	**16**
	1.1 Matrices and Gaussian Elimination The geometry of linear equations, Elimination with matrices, Multiplication and inverse matrices, Factorization into A = LU form, Inverses and Transposes. **1.2 Vector Spaces** Vectors, Lengths and distances, angles, Inner Product, Vector Spaces and Subspaces Solving Ax = 0; pivot variables, solving Ax = b; Rank and nullity of a matrix, Row reduced form R. Linear Independence, Basis, Dimension, Span, Norm. The four fundamental subspaces, Change of basis. **1.3 Orthogonality** Orthogonal vectors and subspaces, Orthogonal and orthonormal Basis. **1.4 Projections onto Subspaces** Projection onto 1-D subspaces, Projection onto 2-D subspaces, Projection matrices and least squares, Orthogonal matrices and Gram-Schmidt procedure. **1.5 Eigen Values and Eigen Vectors** Concepts of Eigen values and Eigen vectors; Diagonalization of a matrix, Eigen decomposition.	

	1.6 Positive Definite Matrices Symmetric matrices and positive definiteness, Positive definite matrices, Similar matrices and Jordan Form, Singular Value Decomposition, Linear Transformation of matrices.	
2	**Probability and Statistics**	**14**
	2.1 Probability Probability definition, Conditional Probability, The Chain Rule of Conditional Probabilities, Independence and Conditional Independence. **2.2 Probability distribution** Binary variables, Bernoulli distribution, Binomial Distribution, Normal Distribution, Student's *t* distribution, chi-squared distribution, Sample and sampling, sampling distribution and Central Limit Theorem. **2.3 Statistics** Mean, Variance and Covariance, Covariance matrix, Covariance and Correlation. Mean of a dataset, Variance of one-dimensional datasets, Variance of higher-dimensional datasets. Linear Transformation of datasets: Effect on the mean, Effect on the (co)variance. **2.4 Statistical Inference** Estimation, Hypothesis Testing, Confidence Interval **2.5 Bayesian Statistics** Bayesian concept learning: Likelihood, Prior, Posterior, Posterior Predictive distribution, MAP estimation.	
3	**Information Theory** Entropy, KL divergence, Mutual information.	**3**
4	**Continuous Optimization** Optimization Using Gradient Descent, Stochastic Gradient Descent, Convex Optimization.	**5**
5	**Mixture Models and EM algorithm** Mixture Models: Mixtures of Gaussians The EM algorithm: Basic idea, EM for GMMs.	**5**
6	**Dimension Reduction Algorithms** **6.1 Introduction** Linear Dimensionality Reduction, Principal component analysis, Factor Analysis, Linear discriminant analysis. **6.2 Non-Linear Dimensionality Reduction** Multidimensional Scaling, Isometric Feature Mapping. Minimal polynomial	**5**
7	**Markov Process** Definition of Markov Process, Discrete Markov chains, The n–step transition probabilities, Steady state probabilities, Chapman-Kolmogorov Theorem, Classification of states of Markov Chain, HMM.	**4**
	Total	**52**

Books Recommended:

Text books:

1. Gilbert Strang, *Linear Algebra and its Applications*, 4th edn, Cengage India Private Limited,2005.
2. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, *Mathematics for Machine Learning*, Cambridge University Press,2020.
3. Kevin P. Murphy, *Machine Learning: A Probabilistic Perspective*, MIT Press, 2012.

Reference Books:

1. Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar. *Foundations of Machine Learning*, MIT Press, 2018.
2. Ian J. Goodfellow, Yoshua Bengio and Aaron Courville, *Deep Learning*, MIT Press, 2016.

Useful Links:

1. https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/
2. *https://archive.nptel.ac.in/courses/111/107/111107137/*

Prepared by Checked by Head of the Department Principal

Honors in Artificial Intelligence & Machine Learning		
Program: Electronics and Telecommunication Engineering	**T. Y. B. Tech**	**Semester: VI**
Course: Concepts and Algorithms of Artificial Intelligence & Machine Learning (DJS22ECHN1C2)		
Course: Concepts and Algorithms of Artificial Intelligence & Machine Learning Laboratory (DJS22ECHN1L1)		

Pre-requisite: --

1. **Mathematics and Statistics for Artificial Intelligence & Machine Learning (DJS22ECHN1C1)**

Objectives:

1. To conceptualize the basic ideas and techniques underlying the design of intelligent systems.
2. To make students understand advanced representation formalism and search techniques.
3. To acquire in depth understanding of various supervised and unsupervised algorithms
4. To demonstrate dimensionality reduction techniques.

Outcomes: On completion of the course, the learner will be able to:

1. Understand basic building blocks of AI present in intelligent agents.
2. Apply an appropriate problem-solving method and knowledge representation technique.
3. Understand fundamental knowledge of developing machine learning models.
4. Design and evaluate an appropriate machine learning model.

Concepts and Algorithms of Artificial Intelligence & Machine Learning (DJS22ECHN1C2)		
Unit	**Description**	**Duration**
1	**Intelligent Agents:** Introduction, AI Intelligent Agents; Structure of Intelligent Agents; Agents and Environments, Types of Agents.	**03**
2	**Introduction to AI Problems** Introduction; Turing Test; Problems in AI.	**02**
3	**Solving Problems in AI: Searching Algorithms as Applied in AI.** Uninformed search BFS, DFS, Depth First with Iterative Deepening, Generate and Test Search Algorithms. Informed/Heuristic search Hill Climbing, Steepest Ascent Hill Climbing, Problems in Hill Climbing, Greedy Nearest Neighbor, Best First Search, Greedy Best First Search, Beam Search, A* search, AO* search algorithms. Constraint satisfaction Search Crypto Arithmetic, Back Tracking: N Queens Problem. Problem Reduction Search AND/OR Graphs, Game Trees. Adversarial search in Games**:** The Min-Max Algorithm on Exhaustively Searchable Graphs, Minimaxing to Fixed Ply Depth, Alpha Beta Pruning.	**10**
4	**Knowledge Representation and Reasoning** Logical Agents Knowledge Based Agents, Wumpus World Knowledge Base Propositional Logic Syntax, Semantics, Inference, Resolution, Problems in Propositional Logic. First Order Logic: Syntax and Semantic of FOL, Using FOL	**08**

	Inference in FOL Propositional vs. First-Order Inference, Unification, Resolution.	
5	**Preparing to model: Data Visualization and Preprocessing**	**05**
	Basic Types of Data in Machine Learning: Plotting and exploring numerical, categorical data, Exploring relationship between variables. Reading Data from varied data sources into Pandas Dataframe, Data visualization in Pie chart, Tree map, Heat map, Scatter plot, Histogram, Box plot. Data Cleaning with Pandas: Filling in Missing values, Cleaning and Filling Missing Data, Drop missing values, Smoothing Noisy data, Removing inconsistencies, Functions in Python Pandas.	
6	**Modelling and Evaluation** Selecting a model: Predictive Models, Descriptive models**.** Training a model: K-fold cross validation method Model representation and Interpretability: Under fitting, Over fitting, Bias-variance Trade off. Evaluating Performance of a Model in Supervised and Unsupervised Learning.	**04**
7	**Supervised Learning:** Linear Regression Algorithms: Simple Linear Regression, Multiple Linear regression, Need for Feature Scaling, Different types of Feature Scaling, Gradient Descent in LR. Logistic Regression: Building Logistic Regression model. Maximum Likelihood Estimation.	**08**
8	**Supervised Learning: Classification** K- Nearest Neighbor Classifier: Choosing Parameters for KNN classifier, KNN Algorithm. Decision Tree Steps to construct a Decision Tree, Classification using Decision Trees. Issues using Decision Tree: Underfitting, Overfitting.Random Tree model. Support Vector Machine Linear SVM: Separating Hyperplane. Optimal Hyperplane: Relationship between Margin and optimal Hyperplane. Equation of Hyperplane, Computation of Distance from a point to the Hyperplane, Computationof the Margin of the Hyperplane.	**07**
9	**Unsupervised Learning** Clustering Different Types of clustering techniques. Partitioning methods.K- means clustering, K-medoids.	**05**
	Total	**52**

Concepts and Algorithms of Artificial Intelligence & Machine Learning Laboratory (DJS22ECHN1L1)	
Sr. No.	**Suggested Experiments List:**
1	Data Visualization with Pandas/Seaborn.
2	Data Cleaning and Pre-processing in Python.
3	Exploratory Data Analysis in Python.
4	Modelling and evaluation with Python.
5	Implement BFS search algorithms to reach goal state
6	Implement DFS search algorithms to reach goal state

7	Implement DFID search algorithms to reach goal state
8	Implement Generate and Test search algorithms to reach goal state
9	Identify and analyze informed search Algorithm to solve the problem. Implement A* search algorithm to reach goal state.
10	Program to implement Local Search algorithm: Hill climbing search
11	Program on Genetic Algorithm to solve an optimization problem in AI.
12	To implement Linear Regression.
13	To implement Logistic Regression.
14	To implement Decision tree algorithm
15	To Implement Naïve Bayes Classifier algorithm.
17	To implement Support Vector Machine.
18	To implement K-Nearest Neighbor.
19	To implement K means Clustering.

Minimum eight experiments from the above suggested list or any other experiment based on syllabus will be included, which would help the learner to apply the concept learnt.

Books Recommended:

Text books:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth Edition" Pearson Education, 2020.
2. Tom M. Mitchell, "Machine Learning", McGraw Hill, 2020.

Reference Books:

1. Saikat Dutt, Amit Das, "Machine Learning," Pearson,2022.
2. Seema Acharya, "Reimagining Data Visualization Using Python," Wiley 2022.
3. Lavika Goel, "Artificial Intelligence: Concepts and Applications," Wiley 2021.

Honors in Artificial Intelligence & Machine Learning		
Program: Electronics and Telecommunication Engineering	**B. Tech**	**Semester: VII**
Course: Deep Learning	**Course Code: DJS22ECHN1C3**	
Course: Deep Learning Laboratory	**Course Code: DJS22ECHN1L2**	

Pre-requisite:

1. Mathematics and Statistics for Artificial Intelligence & Machine Learning
2. Concepts and Algorithms of Artificial Intelligence & Machine Learning

Objectives:

1. To understand Hyper Parameter Tuning
2. To explore Deep Learning Techniques with different learning strategies
3. To design Deep Learning Models for real time applications

Outcomes: On completion of the course, the learner will be able to:

1. Recall the concepts introduced in machine learning and neural network fundamentals.
2. Understand fundamentals of optimization algorithms, Hyper parameter tuning, Neural networks, LSTM, Autoencoders.
3. Apply optimization, classification, and prediction algorithms in CNN, RNN.
4. Analyze various algorithms, performance of different Deep Neural networks identifying their strengths, weaknesses.

Deep Learning (DJS22ECHN1C3)		
Unit	**Description**	**Duration**
1	**Introduction to Deep Learning** History of Deep Learning, Deep Learning Success Stories, McCulloch Pitts Neuron, Multilayer Perceptron (MLPs), Representation Power of MLPs, Sigmoid Neurons, Feed Forward MLPs, Error Function, Back propagation in MLPs, Updating weights. **Optimization techniques:** Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, Ada Grad, RMS Prop, AdaDelta. **Vanishing and Exploding Gradient Problem:** Fixing the vanishing Gradient problem, Gradient Clipping, over fitting, L1 and L2 Regularization.	**12**
2	**Hyper Parameter Tuning Batch Normalization** Tuning Process, Using an Appropriate Scale to pick Hyperparameters, Hyperparameters Tuning in Practice: Pandas vs. Caviar, Normalizing Activations in a Network, Fitting Batch Norm into a Neural Network, why does Batch Norm work, Batch Norm at Test Time. **Effective training in Deep Net**: Early stopping, Dropout, Batch Normalization, Instance Normalization, Group Normalization.	**08**

3	**Convolution Neural Networks** **Components of CNN architecture:** Convolution layer, Pooling or Down Sampling Layer, Flattening Layer, Fully Connected layer, Transfer Learning. **Non-Linearity:** Rectified Linear Unit (ReLU), Leaky ReLU Layer. **Properties of CNN:** Weight Sharing, Translation Invariance. **Architectures of CNN:** LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet.	**12**
4	**Recurrent Neural Networks**: Simple Recurrent Neural Network **Training an RNN:** Back Propagation through time (BPTT), RNN Topology, Vanishing and Exploding Gradients, Long Short-Term Memory (LSTM), Grated Recurrent Unit (GRU).	**08**
5	**Autoencoder:** Types of Auto encoders, Structure of Auto encoders, Regularization in auto encoders, Denoising auto encoders, Sparse auto encoders.	**08**
6	**Applications:** Face Recognition, Optical Character Recognition, Handwritten digit recognition	**04**
	Total	**52**

Deep Learning Laboratory (DJS22ECHN1L2**)**	
Exp.	**Suggested Experiment List**
1	Implementation of different Activation functions and Cost functions in Neural Network.
2	Implementation of different learning rules in MLP.
3	Implementation of Feed Forward networks in a Multilayer Perceptron.
4	Build a three-layer Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.
5	Implementation of Curve Fitting with Deep Neural Networks.
6	Binary Planar data classification with Deep Neural Networks.
7	Handwritten digit—Multiclass classification with Deep Neural Networks.
8	Image Classification with Convolution Neural networks.
9	Audio Classification with Convolution Neural networks.
10	Prediction of a data sequence with simple Recurrent Neural Network.
11	Language Modelling and Generating Text with RNN
12	Handwriting Recognition with LSTM
13	Data Compression with Autoencoders.
14	Data Denoising with Autoencoders.

Minimum eight experiments from the above suggested list or any other experiment based on syllabus to be included, which would help the learner to apply the concept learnt.

Books Recommended:

Textbooks:

1. Ian Goodfellow, *Yoshua Benjio, "Deep Learning*", Alanna Maldonado Publications, 1st Edition, 2023.
2. Jon Krohn, Grant Beyleveld, "*Deep Learning Illustrated",* Pearson Education, 1st Edition, 2020.

Reference Books:

1. Richard O. Duda, Peter E. Hart, David G. Stork, "*Pattern Recognition",* Wiley, 2nd Edition,2021.
2. Francois Chollet, "*Deep Learning with Python"*, Manning Publications, 2nd Edition, 2022.

Prepared by Checked by Head of the Department Principal

Honors in Artificial Intelligence & Machine Learning		
Program: Electronics and Telecommunication Engineering	**B. Tech**	**Semester: VIII**
Course: Pattern Recognition and Machine Learning	**Course Code: DJS22ECHN1C4**	

Pre-requisite:

1. Mathematics and Statistics for Artificial Intelligence & Machine Learning.
2. Concepts and Algorithms of Artificial Intelligence & Machine Learning.
3. Deep Learning

Objectives:

1. To Extract patterns of a given dataset.
2. To Perform Feature Selection and Extraction.
3. To Design efficient models.

Outcomes: At the end of course, student will be able to:

1. Remember fundamental concepts and theories for pattern recognition.
2. Understand different algorithms for pattern recognition.
3. Apply Feature Extraction and Feature Selection to design efficient classifier or clustering model.
4. Analyse different classification and clustering algorithms for large datasets.

Pattern Recognition and Machine Learning (DJS22ECHN1C4)		
Unit	**Description**	**Duration**
1	**Introduction**: What is Pattern Recognition? Data Sets for Pattern Recognition **Different Paradigms for Pattern Recognition:** Statistical Pattern Recognition	08
2	**Representation** **Data Structures for Pattern Representation**: Patterns as Vectors, Patterns as Strings, Logical Descriptions, Patterns as Trees and Graphs **Representation of Clusters** **Proximity Measures:** Distance Measure, Weighted Distance Measure, Non-Metric Similarity Function, Edit Distance 19, Mutual Neighbourhood Distance (MND) **Size of Patterns:** Normalisation of Data, Use of Appropriate Similarity Measures **Abstractions of the Data Set**	10
3	**Feature Extraction:** Fisher's Linear Discriminant, Principal Component Analysis (PCA) **Feature Selection:** Exhaustive Search, Branch and Bound Search	10
4	**Classifying Large Datasets** **Nearest Neighbour Classifier and its Variants:** Weighted Nearest Neighbour, Condensed Nearest Neighbour, Probabilistic Nearest Neighbour, Minimal Distance Classifier.	12

	Efficient Algorithms and Bayesian Classification: The Branch and Bound Algorithm, Bayesian Belief Networks. **Combination of Classifiers:** Introduction to Combining Classifiers, AdaBoost for Classification.	
5	**Clustering Large Datasets:** Incremental Clustering, Divide-and-Conquer Clustering.	08
6	**Application - Document Recognition:** Document Processing, Document Classification and Retrieval	04
	Total	**52**

Books Recommended:

Textbook:

1. Richard O. Duda, Peter E. Hard, David G. Stork, "*Pattern Recognition"*, Wiley, 2nd Edition, 2021.

Reference Book:

1. Christopher M. Bishop, "*Pattern Recognition and Machine Learning"*, Springer, 1st Edition 2020.

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Honors in Intelligent Connectivity : 5G & IoT	**Semester: V**
Program: Electronics & Telecommunication Engineering	
Course: Sensor and Actuator Technology for IoT (DJS22CHHN2C1)	

Pre-requisite: --

1. Basics of Electrical and Electronics Engineering
2. Electronic Devices and Circuits
3. Integrated Circuits

Objectives:

1. To provide understanding of physical parameters and sensing techniques of various sensors.
2. To provide Understanding about signal conditioning principle.
3. To familiarize about MEMS sensors and actuators

Outcomes: On completion of the course, the learner will be able to:

1. To understand the transduction principle of various sensors.
2. To select sensors suitable for required application.
3. To analyze wireless sensing technique.
4. To design data acquisition system.
5. Identify signal conditioning method for particular application.

Sensor and Actuator Technology for IoT (DJS22ECHN2C1)		
Unit	**Description**	**Duration**
1	**Classification and Performance Characteristics of Sensors and Actuators:** Classification of Sensors and Actuators: General Requirements for Interfacing, Units and Measures, Transfer function, Impedance and Impedance matching, Range, Span, Resolution, Accuracy, Errors, Repeatability, Sensitivity and Sensitivity analysis, Hysteresis, Nonlinearity and saturation, Frequency Response, Response Time and Bandwidth, Calibration, Excitation – Deadband, Reliability.	10
2	**Temperature and Optical Sensors and Actuators:** Thermo resistive Sensors: Thermistors, Resistance temperature sensors, Silicon resistive sensors, Thermoelectric Sensors, PN Junction Temperature Sensors, Optical and Acoustical Sensors, Thermo mechanical sensors and Actuators. Optical Sensors and Actuators: Effects of Optical Radiation, Quantum Based Optical Sensors, Photoelectric Sensors, Coupled Charge (CCD) Sensors and Detectors, Thermal Based Optical Sensors, Active Far Infrared (AFIR) Sensors, Optical Actuators	10
3	**Electric, Magnetic, Mechanical Sensors and Actuators:** The Electric Field: Capacitive Sensors and Actuators	10

	Magnetic Fields: Inductive sensors and Hall effect sensors, Magneto hydro dynamic (MHD) Sensors and Actuators, Magnetometers Magnetic Actuators, Voltage and Current Sensors. Mechanical Sensors and Actuators, Radiation Sensors, Mems and Smart Sensors Force Sensors, Accelerometers, Pressure Sensors, Gyroscopes	
4	**Signal Conditioning:** Fundamentals of data Acquisition: Analog and Digital Data acquisition system with different configurations, data loggers, noise and interference. Signal Conditioning: Wheatstone bridge, Flash ADC, R2R DAC. Utilization of Signal Conditioning circuits for Temperature, Pressure, Optical, Strain Gauges, Displacement and Piezoelectric transducers.	06
5	**Current Trends in sensors and Technology Smart Sensors:** Introduction, Primary sensors, Excitation, Amplification, Filters, Converters, Compensation, Information Coding/Processing, Data Communication, Standards for Smart Sensor Interface, The Automation Sensor Technologies: Introduction, Film Sensors, Thick Film Sensors, Thin Film Sensors, Semiconductor IC Technology Standard Methods, Microelectromechanical Systems (MEMS), Nano-sensors Sensor Applications: On-board Automobile sensors, Home appliances sensors, Aerospace Sensors, Sensors for Environmental Monitoring Self-learning Topics: Energy Harvesting, Self-powered Wireless Sensing in ground, Ground penetrating sensors.	10
	Total	**46**

Books Recommended:

Text books:

1. D. Patranabis, *Sensor and Actuators,* 2nd Edition, Prentice Hall of India.
2. A. K. Sawhney, *A course in Electronic Measurements and Instrumentation,*19th Edition, Dhanpat Rai & Co.
3. H. S. Kalsi, *Electronic Instrumentation and Measurements,*4th Edition, McGraw-Hill.
4. Nathan Ida, *Sensors, Actuators and their Interfaces*, SciTech Publishing,2013.

Reference Books:

1. Clarence. W. de Silva, *Sensors and Actuators: Engineering System Instrumentation*, 2nd Edition, CRC Press, 2015.
2. Ernest. O. Doebelin, *Measurement Systems, Application and design*, Tata McGraw- Hill, Publishing Company Ltd., 5th Edition, 2004.
3. D. A. Bradley, D. Dawson, N. C. Burd, A. J. Loader, *Mechatronics*, Thomson Press India Ltd., 2004.
4. S. Renganathan, *Transducer Engineering*, Allied Publishers (P) Ltd., 2003.
5. W. Bolton, Mechatronics, 4th Edition, Pearson Education, 2011.

Prepared by Checked by Head of the Department Principal

Honors in Intelligent Connectivity : 5G & IoT	**Semester: VI**
Program: Electronics & Telecommunication Engineering	
Course: IoT System Design (DJS22ECHN2C2)	
Course: Real Time System Design Laboratory (DJS22ECHN2L1)	

Pre-requisite: --

1. Sensor and Actuator Technology for IoT
2. Computer Networks

Objectives:

1. To provide understanding of enabling technologies.
2. To provide Understanding about IoT sensors and their interfacing.
3. To familiarize about protocols for IoT, Application building with IoT.

Outcomes: On completion of the course, the learner will be able to:

1. To understand the enabling technologies.
2. To select sensors suitable for required application.
3. To analyze protocols for IoT.
4. To Visualize the power of data from the IoT
5. To build the application with IoT

IoT System Design (DJS22ECHN2C2)		
Unit	**Description**	**Duration**
1	**Introduction to Internet of Things** Introduction and Definition of Internet of Things , IoT Growth- A statistical View, Application areas of IoT, Characteristics of IoT, Things in IoT, IoT stack, IoT Enabling Technologies, IoT Challenges, IoT Levels, Cyber Physical system versus IoT, Wireless sensor Network versus IoT, Interfacing with any sensor, Microcontrollers : A Quick walkthrough, Advanced RISC Machine : A Quick Overview.	**10**
2	**Protocols for IoT** Messaging and Transport: Messaging Protocols: Message Queuing Telemetry Transport (MQTT), Constrained Application Protocol (CoAP), Extensible Messaging and Presence Protocol **(**XMPP), Data Distribution Service (DDS)**,** Transport Protocols: Bluetooth Low Energy, Light Fidelity(Li-Fi), Addressing and Identification: A Quick Overview- IPv4,IPv6,IPv5, Uniform Resource Identifier (URI)	**10**

3	**Cloud for IoT** IoT with Cloud- Challenges, Selection of cloud service provider, Introduction to Fog Computing, Cloud computing : security aspects, Architectural Design of Compute and Storage Clouds AWS and AZURE	**6**
4	**Data Analytics- Visualising the power of data from IoT.** Data Analysis, Machine Learning, Types of Machine learning Models, Model building process, Modelling algorithms, Model Performance, Big data Platform, Big Data Pipeline, Real Life Projects, Recommendation in IoT Gadgets	**10**
5	**Application Building with IoT** Introduction, Smart Perishable Tracking with IoT and sensors, Smart Healthcare, Smart Inflight lavatory maintence with IoT, IoT – Based Application to monitor water quality, Smart warehouse Monitoring, Smart Retail, Integrated Vehicle Health management	**9**
	Total	**45**

Books Recommended:

Text books:

1. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, “Internet of Things”, 2nd Edn, Wiley, 2020.
2. Dac-Nhuong Le, Chintan Bhatt, Mani Madhukar “Security Designs for the Cloud, IoT, and Social Networking” John Wiley & Sons, 2019.
3. Marco Schwatrz, “Internet of Things with Arduino Cookbook”, Packt Publications, 2016.
4. Rajkumar Buyya, Christian Vecchiola. S. Thamarai Selvi, “Mastering Cloud Computing”, McGraw Hill Education, 2013.

Reference books:

1. Agus Kurniawan “Learning AWS IoT” Packt Publishing, 2018.
2. Nick Antonopoulos and Lee Gillam, “Cloud Computing: Principles, Systems and Applications”, 2nd Edn, Springer, 2017.

Suggested List of Experiments:

Real Time System Design Laboratory (DJS22ECHN2L1)	
List of Laboratory Experiments: (minimum eight)	
1	Tutorial based on current trends and advancements on IoT
2	Study, discussion, and installation of ARM/Arduino/ESP 32/ RPi
3	Interfacing the sensor with ARM/Arduino / ESP 32 / RPi
4	Interfacing the motor drivers with ARM/ Arduino / ESP 32 / RPi
5	Real time data analysis using sensors, processors, and gateway
6	Interfacing the camera module with ARM/ Arduino / ESP 32 / RPi
7	Real time data base management system using sensors, processors, and gateway
8	Implementation of IoT system Using Messaging and Transport
9	Implementation of data transfer using wireless devices
10	Configuration and using the cloud platform
11	Implementation of IoT system Using Voice Control technique
12	Implementation of IoT system Using Personal Cloud Platform
13	Implementation of IoT system Deep Learning Inference
14	Implementation of IoT system using Artificial Intelligence
15	Implementation of IoT system using Machine Learning
16	Case study based on current trends and advancements on IoT
	Any other experiment may be included, which would help the learner to understand the topic/concept.

Prepared by Checked by Head of the Department Principal

Honors in Intelligent Connectivity: 5G & IoT	**B. Tech**	**Semester: VII**
Program: Electronics & Telecommunication Engineering	**Course Code: DJS22ECHN2C3**	
Course: Intelligent IoT Systems	**Course Code: DJS22ECHN2L2**	

Pre-requisite: -

1. Sensor and Actuator Technology for IoT
2. IoT System Design

Objectives:

1. To provide understanding of physical parameters and sensing techniques of various sensors.
2. To provide Understanding about IIoT Systems.
3. To familiarize about Machine Leaming and Data Science for Intelligent systems.

Outcomes: At the end of course, student will be able to:

1. To understand the basics of CPS.
2. To select sensors suitable for required application.
3. To design an industrial internet system.
4. To identify Business opportunities in IIoT Business Models.
5. To evaluate the information's using Machine Leaming and Data Science.

Intelligent IoT Systems (DJS22ECHN2C3)		
Unit	**Description**	**Duration**
1	Overview of Industry 4.0 and Industrial Internet of Things: Introduction, Industry 4.0. Industrial revolution: Phases of development Evolution of Industry 4.0 Environmental impacts of industrial revolution Industrial Internet Applications of Industry 4.0 IIoT Prerequisites of IIoT Basics of CPS. CPS and IIoT Applications of IIoT.	**10**
2	Industrial Internet of Things: Basics Introduction IIoT and Industry 4.0. IIC Industrial Internet Systems. Design of industrial internet systems Impact of industrial internet Benefits of industrial internet Industrial Sensing Traditional Sensing Contemporary Sensing Industrial Processes. Features of IIoT for industrial processes Industrial plant. The future architecture Viewpoint of industrial processes Digital Enterprise Applications of Industry 4.0.	**10**
3	Business Models and Reference Architecture of IIoT Introduction, Business models, Definition of a business model, Reference architecture Business Models of IoT, Business models of IIoT, Business opportunities in IIoT, Categorization of business models in IIoT, Reference architecture of IoT, Reference Architecture of IIoT, Categorization of reference architecture in IIoT, IIRA frame work: Basics categorization of IIRA frame works, Key Performance Indicators for Occupational Safety and Health.	**10**

4	**Machine Learning and Data Science in Industries** Introduction, Machine Leaming, Categorization of ML Applications of ML in Industries Data Science in Industries Deep Learning Application of Deep Learning in Industries Healthcare Applications in Industries. **Inventory Management and Quality Control:** Introduction, Inventory Management Inventory, Types of inventory management Inventory Management and IIoT, Benefits of IIoT applications in inventory management, Quality Control.	**10**
5	**Case Studies** Introduction Manufacturing Industry: Background of the industry, Challenges Industrial IoT as a solution, Benefits, Automotive Industry: Background of the industry, Challenges, Industrial IoT as a solution, Benefits, Mining Industry: Background of the industry, Challenges Industrial IoT as a solution Benefits. Test Your Understanding: Self Learning Topics based on Problems.	**6**
	Total	**46**

Real Time System Design Laboratory (DJS22ECHN2Ll)	
List of Laboratory Experiments: (minimum eight)	
1	Tutorial based on current trends and advancements on Intelligent IoT Systems
2	Study, discussion, and installation of ARM/Arduino/ESP 32/ RPi /STM32/ RPi PICO
3	Interfacing the sensor with ARM/Arduino / ESP 32 / RPi / STM32/ RPi PICO
4	Interfacing the motor drivers with ARM/ Arduino / ESP 32 / RPi / STM32/ RPi PICO
5	Real time data analysis using sensors, processors, and gateway
6	Interfacing the camera module with ARM/ Arduino / ESP 32 / RPi / STM32/ RPi PICO
7	Real time data base management system using sensors, processors, and gateway
8	Implementation of IIoT system Using Messaging and Transport
9	Implementation of data transfer using wireless devices
10	Configuration and using the cloud platform
11	Implementation of IIoT system Using Voice Control technique
12	Implementation of IIoT system Using Personal Cloud Platform
13	Implementation of IIoT system Deep Learning Inference
14	Implementation of IIoT system using Artificial Intelligence
15	Implementation of IIoT system using Machine Learning
16	Case study based on current trends and advancements on IIoT

Any other experiment may be included, which would help the learner to understand the topic/concept.

Books Recommended:

Textbooks:

1. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, "*Internet of Things*", 2nd Edition, Wiley, 2020.
2. Sudip Misra, Chandana Roy, Anandarup Mukherjee, "*Introduction to Industrial Internet of Tings and Industry 4.0*", 1st Edition published 2021, CRC Press.

Reference books:

1. Agus Kurniawan "*Learning AWS IoT*" Packt Publishing, 1st Edition, 2018.
2. Nick Antonopoulos and Lee Gillam, "*Cloud Computing: Principles, Systems and Applications*", 2nd Edition, Springer, 2017.

Prepared by Checked by Head of the Department Principal

Program: Electronics and Telecommunication Engineering Honors in Intelligent Connectivity: 5G & IoT	B. Tech	Semester: VIII
Course: Fifth Generation Technology	Course Code: DJ22ECHN2C4	

Pre-requisite:

1. Digital Communication (DJS22EC601)
2. Mobile Communication system (DJS22EC702)

Objectives:

1. Learn the basics of 5G and beyond wireless communication
2. Study 5G network architecture, Heterogeneous Network and Small cells
3. Provide an understanding of the key technologies and enablers of 5G and beyondcommunication systems.
4. Learn 5G technology like massive MIMO, mm Wave, etc.

Outcomes: At the end of course, student will be able to:

1. Distinguish between the major cellular communication standards (1G/2G/3G/4G/5G systems) and the architecture of wireless communications networks.
2. Apply the 5G techniques e.g., massive MIMO, mm Wave, etc. for the design of communication systems.
3. Analyse various modulation and multiplexing techniques e.g., OFDM, NOMA, etc.
4. Describe applications of cognitive radio in 5G Wireless Communication

Fifth Generation Technology (DJS22ECHN2C4)		
Unit	**Description**	**Duration**
1	**Introduction:** Introduction to 5G Technology, Features, Requirements, Applications, 5G Services, Introduction to 5G Digital modulations (OFDM, 5G Technology Modulation Techniques) and performance metrics, Evolution of Air Interface Towards 5G, 5G Internet, Internet of Things and Context-Awareness, Software Defined Networking, 5G NR Network Function, Virtualization (NFV) 5G NR	**10**
2	**5G Architecture:** 5G Network Architecture, Cloud RAN(C-RAN), Definitions of Heterogeneous Networks, Radio Resource and Interference Management for Heterogeneous Networks, Traffic offloading scenarios for heterogeneous networks, mobility management, and handover, Small cell deployments: different types, Deployment scenarios, performance, and analysis, Energy-efficient mechanism with BS sleep mode in green small cell networks, Game theory and learning techniques for self-organization in small cell networks, 3GPP RAN standards for small cell	**12**

3	**MmWave:** mmWave Millimeter bands, radio-wave propagation Physical layer design and algorithms, mmWave MIMO challenges, channel modelling, channel estimation, and Beamforming. Types of transceivers, Merits, and Demerits, Applications - Beamforming Physical or Radio layer Technologies - Massive MIMO (Sub 6Ghz) mmWave MIMO (above 6 GHz)	**10**
4	**NOMA:** Nonorthogonal Multiple Access (NOMA), Different Types: power domain NOMA and code domain NOMA, Difference between Orthogonal multiple access and NOMA, Filter Bank multi-carrier -Full duplex Radio Techniques, Precoding	**10**
5	**Trends in 5G:** 5G NR, Carrier Aggregation in 5G, Open RAN, Use cases of 5G: eMBB, URLLC, and mMTC, Advance applications: Robotic surgery, driverless car and Industrial IoT (IIoT), Tactile Internet, 5G-IoT applications, AR/VR in 5G (The Next Generation Wireless Access Technology)	**04**
	Total	**46**

Books Recommended:

Textbooks:

1. Aditya K. Jagannatham, "*Principles of Modern Wireless Communication Systems Theory andPractice*", McGraw Hill Education, 1st Edition, 2017.
2. Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock, "*Millimeter Wave Wireless Communication*", Prentice Hall, 1st Edition, 2014.

Reference Books:

1. R. Vannithamby and S. Talwar, "*Towards 5G: Applications, Requirements and CandidateTechnologies*", John Willey & Sons, West Sussex, 1st Edition, 2017.
2. Manish, M., Devendra, G, Pattanayak, P, Ha, N, "*5G and Beyond Wireless Systems PHY Layer Perspective, Series in Wireless Technology*" Springer, 1st Edition, 2021.
3. M. Vaezi, Z. Ding, and H. V. Poor, "*Multiple Access techniques for 5G Wireless Networks andBeyond*", Springer Nature, 1st Edition, Switzerland, 2019.
4. Sassan Ahmadi, "*5G NR: Architecture, Technology, Implementation, and Operation of 3GPPNew Radio Standards*", Academic Press, 1st Edition, 2019.
5. Suvra Sekhar Das, Ramjee Prasad "*Evolution of Air Interface Towards 5G: Radio Access Technology and Performance Analysis*", River Publishers, 1st Edition, 2018.

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Minor in IoT and Industry 4.0	**Semester: V**
Program: Common for All Programs (except EXTC Engineering)	
Course: Sensor Technology (DJS22MN8C1)	

Pre-requisite: --

1. Basics of Electrical and Electronics Engineering

Objectives:

1. To provide understanding of physical parameters and sensing techniques of various sensors.
2. To provide Understanding about signal conditioning principle.
3. To familiarize about MEMS sensors and actuators.

Outcomes: On completion of the course, the learner will be able to:

1. To understand the transduction principle of various sensors
2. To select sensors suitable for required application
3. To analyze wireless sensing technique
4. To design data acquisition system.
5. Identify signal conditioning method for particular application

IoT and Industry 4.0 (DJS22MN8C1)		
Unit	**Description**	**Duration**
1	**Classification and Performance Characteristics of Sensors and Actuators:** Classification of Sensors and Actuators: General Requirements for Interfacing, Units and Measures, Transfer function, Impedance and Impedance matching, Range, Span, Resolution, Accuracy, Errors, Repeatability, Sensitivity and Sensitivity analysis, Hysteresis, Nonlinearity and saturation, Frequency Response, Response Time and Bandwidth, Calibration, Excitation, Deadband, Reliability.	10
2	**Temperature and Optical Sensors and Actuators:** Thermo resistive Sensors: Thermistors, Resistance temperature sensors, Silicon resistive sensors, Thermoelectric Sensors, PN Junction Temperature Sensors, Optical and Acoustical Sensors, Thermo mechanical sensors and Actuators. Optical Sensors and Actuators: Effects of Optical Radiation, Quantum Based Optical Sensors, Photoelectric Sensors, Coupled Charge (CCD) Sensors and Detectors, Thermal Based Optical Sensors, Optical Actuators.	10
3	**Electric, Magnetic, Mechanical Sensors and Actuators:** The Electric Field: Capacitive Sensors and Actuators Magnetic Fields: Inductive sensors and Hall effect sensors, Sensors and Actuators, Magnetometers Magnetic Actuators, Voltage and Current Sensors.	10

	Mechanical Sensors And Actuators, Radiation Sensors, Accelerometers, Pressure Sensors, Gyroscopes.	
4	**Signal Conditioning:** Fundamentals of data Acquisition: Analog and Digital Data acquisition system with different configurations, data loggers, noise and interference. Signal Conditioning: Wheatstone bridge, Flash ADC, R2R DAC. Utilization of Signal Conditioning circuits for Temperature, Pressure, Optical, Strain Gauges, Displacement and Piezoelectric transducers.	06
5	**Current Trends in sensors:** Introduction, Primary sensors, Excitation, Amplification, Filters, Converters, Compensation, Information Coding/Processing, Data Communication, Standards for Smart Sensor Interface, The Automation Sensor Technologies: Introduction, Film Sensors, Thick Film Sensors, Thin Film Sensors, Semiconductor IC Technology Standard Methods, Microelectromechanical Systems (MEMS), Nano-sensors Sensor Applications: On-board Automobile sensors, Home appliances sensors, Aerospace Sensors, Sensors for Environmental Monitoring Self-learning Topics: Energy Harvesting, Self-powered Wireless Sensing in ground, Ground penetrating sensors.	10
	Total	**46**

Books Recommended:

Text books:

1. D. Patranabis, *Sensor and Actuators*, 2nd Edition, Prentice Hall of India.
2. A. K. Sawhney, *A course in Electronic Measurements and Instrumentation,*19th Edition, Dhanpat Rai & Co.
3. H. S. Kalsi, *Electronic Instrumentation and Measurements,*4th Edition, McGraw-Hill.
4. Nathan Ida, *Sensors, Actuators and their Interfaces*, SciTech Publishing,2013.

Reference Books:

1. Clarence. W. de Silva, *Sensors and Actuators: Engineering System Instrumentation*, 2nd Edition, CRC Press, 2015.
2. Ernest. O. Doebelin, *Measurement Systems, Application and design*, Tata McGraw- Hill, Publishing Company Ltd., 5th Edition, 2004.
3. D. A. Bradley, D. Dawson, N. C. Burd, A. J. Loader, *Mechatronics*, Thomson Press India Ltd., 2004.
4. S. Renganathan, *Transducer Engineering,* Allied Publishers (P) Ltd., 2003.
5. W. Bolton, Mechatronics, 4th Edition, Pearson Education, 2011.

Prepared by Checked by Head of the Department Principal

Minors in IoT and Industry 4.0	**Semester:** VI
Program: Common for All Programs (Except Electronics & Telecommunication Engineering)	
Course: IoT System Design	

Pre-requisite: --

1. Sensor and Actuator Technology for IoT
2. Computer Networks

Objectives:

1. To provide understanding of enabling technologies.
2. To provide Understanding about IoT sensors and their interfacing.
3. To familiarize about protocols for IoT, Application building with IoT.

Outcomes: On completion of the course, the learner will be able to:

1. To understand the enabling technologies.
2. To select sensors suitable for required application.
3. To analyze protocols for IoT.
4. To Visualize the power of data from the IoT
5. To build the application with IoT

IoT System Design (DJS22MN8C2)		
Unit	**Description**	**Duration**
1	**Introduction to Internet of Things** Introduction and Definition of Internet of Things , IoT Growth- A statistical View, Application areas of IoT, Characteristics of IoT, Things in IoT, IoT stack, IoT Enabling Technologies, IoT Challenges, IoT Levels, Cyber Physical system versus IoT, Wireless sensor Network versus IoT, Interfacing with any sensor	**10**
2	**Protocols for IoT** Messaging and Transport: Messaging Protocols : Message Queuing Telemetry Transport (MQTT),Constrained Application Protocol (CoAP), Extensible Messaging and Presence Protocol **(**XMPP) , Data Distribution Service (DDS) **,** Transport Protocols : Bluetooth Low Energy, Light Fidelity(Li-Fi),	**10**
3	**Cloud for IoT** IoT with Cloud- Challenges, Selection of cloud service provider, Introduction to Fog Computing, Cloud computing : security aspects, Architectural Design of Compute and Storage Clouds AWS and AZURE	**6**

4	**Data Analytics- Visualising the power of data from IoT.** Data Analysis, Machine Learning, Types of Machine learning Models, Model building process, Modelling algorithms, Model Performance, Big data Platform, Big Data Pipeline, Real Life Projects, Recommendation in IoT Gadgets	**10**
5	**Application Building with IoT** Introduction, Smart Perishable Tracking with IoT and sensors, Smart Healthcare, Smart Inflight lavatory maintence with IoT, IoT – Based Application to monitor water quality, Smart warehouse Monitoring, Smart Retail, Integrated Vehicle Health management	**9**
	Total	**45**

Books Recommended:

Text books:

1. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, “Internet of Things”, 2nd Edn, Wiley, 2020.
2. Dac-Nhuong Le, Chintan Bhatt, Mani Madhukar “Security Designs for the Cloud, IoT, and Social Networking” John Wiley & Sons, 2019.
3. Marco Schwatrz, “Internet of Things with Arduino Cookbook”, Packt Publications, 2016.
4. Rajkumar Buyya, Christian Vecchiola. S. ThamaraiSelvi, “Mastering Cloud Computing”, McGraw Hill Education, 2013.

Reference books:

1. Agus Kurniawan “Learning AWS IoT” Packt Publishing, 2018.
2. Nick Antonopoulos and Lee Gillam, “Cloud Computing: Principles, Systems and Applications”, 2nd Edn, Springer, 2017.

Prepared by Checked by Head of the Department Principal

Program: Common for All Programs (except EXTC Engineering) Minor in IoT and Industry 4.0	B. Tech	Semester: VII
Course: IoT Network Design	Course Code: DJS22MN8C3	
Course: IoT System and Network Design Laboratory	Course Code: DJS22ECHN2L2	

Pre-requisite:

1. Sensor and Actuator Technology for IoT (DJS22ECHN2C2)
2. IoT System Design (DJS22ECHN2C2)

Objectives:

1. To provide understanding of physical parameters and sensing techniques of various sensors.
2. To provide Understanding about IIoT Systems.
3. To familiarize about Machine Leaming and Data Science for Intelligent systems

Outcomes: At the end of course, student will be able to:

1. To understand the basics of CPS.
2. To select sensors suitable for required application.
3. To design an industrial internet system.
4. To identify Business opportunities in IIoT Business Models.
5. To evaluate the information's using Machine Learning and Data Science.

IoT Ne| twork Design (DJS22MN8C3)		
Unit	**Description**	**Duration**
1	**Overview of Industry 4.0 and Industrial Internet of Things:** Introduction, Industry 4.0, Industrial revolution: Phases of development Evolution of Industry 4.0 Environmental impacts of industrial revolution Industrial Internet Applications of industry 4.0 IIoT Prerequisites of IIoT Basics of CPS. CPS and IIoT Applications of IIoT.	10
2	**Industrial Internet of Things:** Basics Introduction IIoT and Industry 4.0. IIC Industrial Internet Systems. Design of industrial internet systems Impact of industrial internet Benefits of industrial internet Industrial Sensing Traditional Sensing Contemporary Sensing Industrial Processes. Features of IIoT for industrial processes Industrial plant the future architecture View point of industrial processes Digital Enterprise Applications of Industry 4.0.	10
3	**Business Models and Reference Architecture of IIoT:** Introduction, Business models, Definition of a business model, Reference architecture Business Models of IoT, Business models of IIoT, Business opportunities in IIoT, Categorization of business models in IIoT, Reference architecture of IoT, Reference Architecture of IIoT, Categorization of reference architecture in IIoT	10

4	**Machine Learning and Data Science in Industries:** Introduction, Machine Learning, Categorization of ML Applications of ML in Industries Data Science in Industries Deep Learning Application of Deep Learning in Industries Healthcare Applications in Industries **Inventory Management and Quality Control:** Introduction, Inventory Management Inventory, Types of inventory management Inventory Management and IIoT, Benefits of IIoT applications in inventory management, Quality Control	10
5	**IIoT Analytics** Introduction to IIoT Analytics, Introduction., Necessity of analytics. IIoT Analytics Categorization of analytics: IloTandindustry4.0 Usefulness of IIoT analytics Challenges of analytics in industries Mapping of analytics with the URA architecture Deployment of analytics. Artificial intelligence. Applications of analytics across value chain	6
	Total	**46**

IoT System and Network Design Laboratory (DJS22ECHN2L2)	
List of Laboratory Experiments: (minimum eight)	
1	Tutorial based on current trends and advancements on IoT
2	Study, discussion, and installation of ARM/Arduino/ESP 32/ RPi
3	Interfacing the sensor with ARM/Arduino / ESP 32 / RPi
4	Interfacing the motor drivers with ARM/ Arduino / ESP 32 / RPi
5	Real time data analysis using sensors, processors, and gateway
6	Interfacing the camera module with ARM/ Arduino *I* ESP 32 *I* RPi
7	Real time data base management system using sensors, processors, and gateway
8	Implementation of IoT system Using Messaging and Transport
9	Implementation of data transfer using wireless devices
10	Configuration and using the cloud platform

Any other experiment may be included, which would help the learner to understand the topic/concept.

Books Recommended:

Textbooks:

1. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, "*Internet of Things*", Wiley, 2nd Edition, 2020.
2. Dac-Nhuong Le, Chintan Bhatt, Mani Madhukar, *"Security Designs for the Cloud, IoT, and Social Networking*" John Wiley & Sons, 1st Edition, 2019.
3. Marco Schwatrz, "*Internet of Things with Arduino Cookbook*", Packt Publications, 1st Edition, 2016.
4. Rajkumar Buyya, Christian Vecchiola. S. Thamarai Selvi, "*Mastering Cloud Computing*", McGraw Hill Education, 1st Edition, 2013.

Reference books:

1. Agus Kumiawan, "*Learning AWS IoT*", Packt Publishing, 1st Edition, 2018.
2. Nick Antonopoulos and Lee Gillam, "*Cloud Computing: Principles, Systems and Applications*", Springer, 2nd Edition, 2017.

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