Shri Vile Parle Kelavani Mandal's

Dwarkadas J. Sanghvi College of Engineering

(Autonomous College Affiliated to the University of Mumbai)

Scheme and detailed syllabus (DJ19)

Final Year B.Tech

in

Computer Science and Engineering (Data Science)

(Semester VII)

Scheme of Semester VII for Department of Computer Science and Engineering (Data Science)
Academic Year 2023-24

Sr	Course Code	Course	Teaching Scheme				Semester End Examination (A)					Continuous Assessment (B)					Aggregate (A+B)	Credit	
			Theory (hrs.)	Practical (hrs.)	Tutorial (hrs.)	Credits	Duration (Hrs)	Theory	Oral	Pract	Oral & Pract	End Sem Exam Total	Term Test 1 (TT1)	Term Test 2 (TT2)	Avg (TT1 & TT2)	Term Work	CA Total		
1	DJ19DSC701	Machine Learning - IV	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	4
	DJ19DSL701	Machine Learning - IV Laboratory	--	2	--	1	--	--	25	--	--	25	--	--	--	25	25	50	1	
2	DJ19DSC702	Image Processing and Computer Vision - II	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	4
	DJ19DSL702	Image Processing and Computer Vision - II Laboratory	--	2	--	1	2	--	--	--	--	--	--	--	--	25	25	25	1	
3	DJ19DSL703	Applied Data Science Laboratory	--	2	--	1	--	--	--	--	--	--	--	--	--	50	50	50	1	1
4@	DJ19DSC7011	Parellel Computing	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	4
	DJ19DSL7011	Parellel Computing Laboratory	--	2	--	1	--	--	--	--	--	--	--	--	--	25	25	25	1	
	DJ19DSC7012	Advanced Computational Linguistics	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19DSL7012	Advanced Computational Linguistics Laboratory	--	2	--	1	--	--	--	--	--	--	--	--	--	25	25	25	1	
	DJ19DSC7013	IoT Network Enterprise	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19DSL7013	IoT Network Enterprise Laboratory	--	2	--	1	--	--	--	--	--	--	--	--	--	25	25	25	1	
	DJ19DSC7014	Adversarial Machine Learning	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19DSL7014	Adversarial Machine Learning Laboratory	--	2	--	1	--	--	--	--	--	--	--	--	--	25	25	25	1	
5#	DJ19ILO7011	Product Life Cycle Management	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	3
	DJ19ILO7012	Management Information System	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO7013	Operations Research	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO7014	Cyber Security and Laws	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO7015	Personal Finance Management	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO7016	Energy Audit and Management	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO7017	Disaster Management and Mitigation Measures	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO7018	Science of Well-being	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO7019	Research Methodology	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO7020	Public Systems and Policies	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
6	DJ19DSP704	Project Stage - I	--	4	--	2	2	--	50	--	--	50	--	--	--	50	50	100	2	2
		Total	**48**	**18**	**0**	**57**	**52**	**1200**	**75**	**0**	**0**	**1275**	**400**	**400**	**400**	**250**	**650**	**1925**	**57**	**18**

@ Any 1 Elective Course

\# Any 1 Institute Professional Elective

Continuous Assessment (A):

Course	Assessment Tools	Marks	Time (hrs.)
Theory	a. One Term test (based on 40 % syllabus)	25	1
	b. Second Term test (next 40 % syllabus) / presentation / assignment / course project / group discussion / any other.	25	1
	Average marks of a and b	25	--
Audit course	Performance in the assignments / qui / power point presentation / poster presentation / group project / any other tool.	--	As applicable
Laboratory	Performance in the laboratory and documentation.	25	
Tutorial	Performance in each tutorial & / assignment.	25	
Laboratory &Tutorial	Performance in the laboratory and tutorial.	50	

The final certification and acceptance of term work will be subject to satisfactory performance upon fulfilling minimum passing criteria in the term work / completion of audit course.

Semester End Assessment (B):

Course	Assessment Tools	Marks	Time (hrs.)
Theory / * Computer based	Written paper based on the entire syllabus.	75	3
	* Computer based assessment in the college premises.		
Oral	Questions based on the entire syllabus.	25	as applicable
Practical	Performance of the practical assigned during the examination and the output / results obtained.	25	2
Oral & Practical	Project based courses - Performance of the practical assigned during the examination and the output / results obtained. Based on the practical performed during the examination and on the entire syllabus.	As per the scheme	2

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Program: B.Tech in Computer Science and Engineering (Data Science)	Final Year. B.Tech	Semester: VII
Course: Machine Learning - IV (DJ19DSC701)		
Course: Machine Learning - IV Laboratory (DJ19DSL701)		

Pre-requisite:
1. Basic Machine Learning
2. Database Management System

Objectives:
To teach advance concepts of data management and data analysis for Big Data.

Outcomes: On completion of the course, the learner will be able to:
1. Evaluate the need of MapReduce framework.
2. Apply appropriate method to handle big data.
3. Apply suitable analysis method to draw conclusions from given big data.

Machine Learning - IV (DJ19DSC701)		
Unit	**Description**	**Duration**
1	**Map-Reduce:** The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of Map-Reduce Execution, Coping with Node Failure; Algorithms using MapReduce: Matrix-Vector multiplication by MapReduce, Selection, Projection, Natural Join, Union, Intersection, Difference, Matrix Multiplication.	**04**
2	**Mining Data Stream:** The Stream Model, Sampling Data in a Stream, Filtering Streams: The Bloom Filter; Counting distinct element in the Stream: The Count-Distinct Problem, The Flajolet-Martin Algorithm; Estimating Moments: The Alon-Matias-Szegedy Algorithm for Second Moments, Higher-Order Moments, Dealing with Infinite Streams; Counting ones in a window: The cost of exact count, The DGIM algorithm, Storage Requirement, Query Answering.	**08**
3	**Link Analysis:** PageRank: Search Engine, Term Spam, PageRank, Structure of Web, Avoiding Dead Ends, Spider Traps and Taxation, Efficient Computing of PageRank: Transition Matrices, Iteration using MapReduce, Topic Sensitive PageRank: Biased Random Walk, Using Topic Sensitive PageRank, Inferring Topics from Words. Link Spam: Architecture, Analysis of Spam Farm, Combating Link Spam, Trust Rank, Spam Mass. Hubs and Authorities, HITs Algorithm.	**08**
4	**Frequent Itemsets:** The Market-Basket model: Association Rules, A-Priori, Representation of Market-Basket Data, Monotonicity of itemset, Handling Larger Datasets in Main Memory: The Multistage Algorithm, The Multihash Algorithm, Limited-Pass Algorithms: Randomized Algorithm, Avoiding error in sampling algorithms, Counting Frequent Itemsets in a Stream: Frequent Itemsets in a decaying window.	**06**

5	**Clustering:** Clustering Strategies, The Curse of Dimensionality, Hierarchal Clustering in a Euclidean Space and Non-Euclidean Spaces, The CURE Algorithm: Initialization, Completion, Representing Clusters in a GRGPF Algorithm, Initializing Cluster Tree, Adding Points, Splitting and Merging Clusters. Clustering for Streams and Parallelism: The Stream-Computing Model, Initializing, Merging Buckets, Answering Queries.	06
6	**Social Network Analysis:** Social Networks as Graphs, Clustering of Social Network Graphs: Distance Measure, Betweenness, The Girvan- Newman Algorithm, Betweenness to find communities, Direct discoveries of Communities: Finding Cliques, Complete Bipartite Graphs, Partition of Graphs: Normalized Cuts, Contents: Finding overlapping communities, Maximum Likelihood Estimation, The Affiliation Graph Model, SimRank: Random walkers on Social Media, Approximate SimRank, Counting Triangles, Neighborhood Properties of a graph.	07
	Total	**39**

Machine Learning - IV Laboratory (DJ19DSL701)	
Exp.	**Suggested experiments**
1	Execute Matrix Multiplication using MapReduce.
2	Perform Sorting using MapReduce.
3	Implement Bloom Filter using MapReduce.
4	Approximate the number of unique elements in a data stream or database in one pass using Flajolet-Martin Algorithm.
5	Compute stochastic matrix from a given graph, compute PageRank vector and return the results.
6	Identify which page belongs to Link farm in a given graph. Compute trustrank vector.
7	Perform Market-Basket analysis using MapReduce.
8	Video Summarization using Cure Algorithm.
9	Community detection using Girvan- Newman Algorithm.
10	Similarity analysis using SimRank.

Minimum eight tutorials based on syllabus will be conducted. Mini project relevant to the subject may be included, which would help the learner to apply the concept learnt.

*The Term Work will be calculated based on Laboratory Performance (15m) and Assignments (10m).

Books Recommended:

Text books:
1. Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman, Mining of Massive Datasets, Stanford Press, 2020.
2. Donald Miner, Adam Shook, MapReduce Design Patterns: Building Effective Algorithms and Analytics for Hadoop and Other Systems, O'Reilly, 2013.

Reference Books:
1. Suk-Man Ivy Tong, Techniques in Data Stream Mining, Open Dissertation Press, 2017.

2. Leszek Ruthowski, Maciej Jawordki, Plotr Duda, Stream Data Mining: Algorithms and Their Probabilistic Properties, Springer, 2019

3. A biefet, Adaptive Stream Mining: Pattern Learning and Mining from Evolving Data Stream, IoS Press, 2010

4. Amy N Langville, Carl D. D. Meyer, Google's PageRank and Beyond: The Science of Search Engine Rankings, Princeton University Press 2011.

5. Dr. Chandrashekhar Raghuvanshi, Dr. Hari Om Sharan, Frequent Pattern Mining in Large Databases, AkiNik Publication, 2022.

6. Tanmoy Chakraborty, Social Network Analysis, Wiley Publication, 2021.

Web Links:
1. Concept Drift: https://ebrary.net/199293/engineering/sampling_data_streams
2. Search Engine: https://moz.com/blog/search-engine-algorithm-basics

Program: B.Tech in Computer Science and Engineering (Data Science)	Final Year. B.Tech	Semester: VII
Course: Image Processing and Computer Vision – II (DJ19DSC702)		
Course: Image Processing and Computer Vision - II Laboratory (DJ19DSL702)		

Pre-requisite:
1. Mathematics for Intelligent System
2. Machine Learning -I and II
3. IP-CV -I

Objectives:

To introduce theory and computation related to imaging geometry, and scene understanding. Also, to provide exposure to clustering, classification and deep learning techniques applied in computer vision.

Outcomes: On completion of the course, the learner will be able to:
1. Understand various data capturing methods.
2. Apply appropriate object detection and object segmentation methods.
3. Apply suitable method to analyze complex vision data.
4. Develop suitable vision model for prediction.

Image Processing and Computer Vision – II (DJ19DSC702)		
Unit	Description	Duration
1	**Camera Geometry Model:** Basics of Real Aperture Camera, Lens as LSI System, Geometric Projective, 2D Transformations, 3D Transformations, Homography Computation, planar homography, Camera geometry, Stereo geometry, Linear Filtering, Correlation, Convolution, Hierarchy of Transformations, Rotational Representation, Weak perspective projection and orthographic projection, coordinate system, camera parameters and camera calibration Algorithm.	**06**
2	**Object Detection:** **Two Stage/Proposal**: Convolutional Neural Networks for Detection: R-CNN, Fast R-CNN, Faster R-CNN, RFCN and Mask RCN; Architecture and Issues in each algorithm. visualization of Kernels; Backprop-to-image/Deconvolution Methods; **One Stage/Proposal Free**: YOLO, SSD, evaluation metrics (IoU, AP), Non-max suppression YOLO Loss function, Variants of YOLO. **Face Recognition and Verification:** Zero-shot, One-shot, Few-shot Learning; Siamese Networks, Triplet Loss, Contrastive Loss, Ranking Loss; Attention Models in Vision, Spatio-temporal Models, Action/Activity Recognition, Region-based convolutional neural network, Semantic segmentation	**08**
3	**Generative Models:** Types of generative models: Implicit and Explicit density; Generative Adversarial Network; Vanilla GAN, Mode Collapse in GAN, Conditional GAN, DC GAN, GAN objective functions, JSD Divergence, EM Distance Least Squares.	**06**
4	**Transfer Learning:** Introduction to Transfer Learning, Options in Transfer Learning, Transfer Learning with ResNet50, Network architecture for Object Localization, Evaluating Object Localization, AlexNet, VGG and Inception architectures, Fine-grained image	**06**

	recognition, Detection and classification of facial attributes, Content based image retrieval, Computing semantic image embeddings using convolutional neural networks, Employing indexing structures for efficient retrieval of semantic neighbors, The reidentification problem in computer vision Facial key points regression, CNN for key points regression. Ensemble methods; Bagging.	
5	**Object Segmentation:** Semantic segmentation, Scene Parsing, semantic flow, Bilinear Interpolation, Symmetry in Segmentation, Featured image pyramid, pixel-wise softmax , PSPNet, FPN, UNet, SyNet, clustering method for segmentation, Distance metrics(Euclidean, Cosine, Hamming, Manhattan, Minkowski, Chebyshev, Jaccard, Haversine, Sorensen-Dice), Linkage Types (Single, Average, Complete, Centroid)	07
6	**Motion Analysis and action recognition:** Introduction to motion analysis, Horn and Shunck method, Lucas-Kanade algorithm for optical flow, Deep learning in optical flow estimation. Motion models. Introduction to action recognition, Action classification, Action localization. Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation. Visual object tracking methods and its examples, multiple objects tracking methods, Tomasi and Kanade Motion factorization algorithm, Applications of feature point tracking: mosaicing, video stabilization, structure from motion.	06
	Total	**39**

Image Processing and Computer Vision - II Laboratory (DJ19DSL702)	
Exp.	**Suggested experiments**
1	Object Detection (CNN): Cancer Cells Detection using Medical Image Processing.
2	Object Detection (CNN): Comparative analysis of different CNN models on Image Dataset.
3	Object Detection (YOLO): Identifying vehicle from a Road Traffic CCTV video Footage.
4	Face Recognition: Facial Key Point Detection, Face verification, Hybrid image formation for identification of facial expression classification and detection.
5	GAN: Converting Black and white image into Colored image.
6	GAN: Deep fake Detection.
7	Transfer Learning: Document Extraction from a pre-defined format.
8	Transfer Learning: Satellite Image classification and Segmentation.
9	Image Segmentation: Image Categorization for a given Vision Dataset.
10	Motion Analysis: Spatio-Temporal Analysis for Body Postures.
11	Mini Project

Subject Teacher can select any six experiments from the given list or add new experiments. At least one experiment on each: CNN, YOLO, GAN, Transfer Learning, U-Net should be implemented.

*The Term Work will be calculated based on Laboratory Performance (15m) and Computer Based Assessment/Mini Project (10m).

Books Recommended:

Text books:

1. David Forsyth, Jean Ponce, Computer Vision: A Modern Approach, Pearson Education, 2003.

2. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
3. M.K. Bhuyan, Computer Vision and Image Processing: Fundamentals and Applications, CRC Press, USA, ISBN 9780815370840 - CAT# K338147.
4. E.R. Davies, Computer Vision: Principles, Algorithms, Applications, learning, 5th Edition 2017.
5. Emanuele Trucco and Alessandro Verri, Introductory Techniques for 3D Computer Vision, Prentice Hall, 1998.
6. B. K. P. Horn, Robot Vision, MIT Press (Cambridge), 1986.

Reference Books:
1. Jan Erik Solem, Programming Computer Vision With Python: Tools And Algorithms For Analyzing Images, O'reilly Publication, 2012.
2. Adrian Kaehler and Gary Bradski, Learning OpenCV Computer Vision with OpenCV library, O'reilly Publication 2008.
3. Benjamin Planche, Eliot Andres, Hands-on Computer Vision with TensorFlow 2, Packt Publication, 2019.
4. Simon Prince, Computer Vision: Models, Learning, and Inference, 2012.
5. Natural Image Statistics, by Aapo Hyvarinen, Jarmo Hurri and Patrick Hoyer, Springer Verlag 2009
6. A Mathematical Introduction to Compressive Sensing", by Simon Foucart and Holger Rauhut, Birkhauser, 2013.
7. Statistical Learning with Sparsity: The Lasso and Generalizations", by Hastie, Tibshirani and Wainwright, CRC press, 2015.
8. Multiple View Geometry in Computer Vision: R. Hartley and A. Zisserman, Cambridge University Press, 2000.

Web Links:

1. Virtual Lab on Vision and deep learning Lab, https://www.ee.iitb.ac.in/~viplab/
2. Virtual Lab on Computer Vision Laboratory https://www.iitk.ac.in/ee/computer-vision-lab
3. Course on Modern Computer Vision
   https://www.youtube.com/playlist?list=PLzWRmD0Vi2KVsrCqA4VnztE4t71KnTnP5
4. Coursera course on Advanced Computer Vision with TensorFlow
   https://www.coursera.org/learn/advanced-computer-vision-with-tensorflow
5. Udemy course on Deep Learning and Computer Vision A-Z™: OpenCV, SSD & GANs | Udemy
6. Vision Lab: Computeer Vision http://cse.iitm.ac.in/lab_details.php?arg=NQ
7. Funded Projects on Computer Vision at NAVER LABS Europe
   https://europe.naverlabs.com/research/computer-vision/

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Program: B.Tech in Computer Science and Engineering (Data Science)	Final Year. B.Tech	Semester: VII
Course: Applied Data Science Laboratory (DJ19DSL703)		

Pre-requisite:
1. Machine Learning
2. Data Engineering

Objectives:
To bridge the gaps between industry and academia. Give the exposure of production system and applied data science.

Outcomes: On completion of the course, the learner will be able to:
1. Relate to production systems available in the industry.
2. Debug various problems occurred in a data science production system.

Applied Data Science Laboratory (DJ19DSL703)		
S No	**Description**	**Duration**
1	**Converting Business problem into Data Science Problem:** • Bridging the Qualitative-to-Quantitative Gap in Data Science • Right Data Available with the Right Level of Granularity • Repeatability and Reproducibility: Consistency in Labelled Data for Accurate AI Systems	02
2	**Agile Methodology:** • Work Breakdown structure for Agile Models • Scrum/XP modelling of Data Science Projects • Agile Tools for Project Management	04
3	**Data Preparation Best Practice:** • Gathering suitable data for Data Science problem • Determine all Key Performance Indicators (KPIs) • Business stakeholders POC Dashboard	02
4	**Data Modelling:** • Selection of appropriate tool • Data Modelling with Incremental Data • Data Modelling with Noisy Data. • Data Modelling with different data formats	04
5	**Model Building Best Practice:** • One hot encoding • Selecting right metrics to evaluate the model • Identify and minimize Data Leakage	02
6	**Modelling and Optimisation Trade-off:** • Need of Optimisation • Different methods of Optimization • Development • Rest APIs	02
7	**Data Science Project Architecture:**	02

	• Functions of MLOps/DevOps • Difference between MLOps and DevOps • Collaboration, Scalability and Reusability	
8	**Project Deployment:** • Flask • Docker • Kubernetes	04
9	**A/B Testing:** • Formulate Hypothesis • Create Test Group • Compare Results	02
	Total	24

Based on the given topics subject teachers can prepare 10 experiments consisting of each section.

*The Term Work will be calculated based on Laboratory Performance (15m) and Quizzes (10m).

Books Recommended:

Text books:

1. Probyto Data Science and Consulting Pvt. Ltd, Data Science for Business Professionals, bpb publications, 2020.
2. Emmanuel Ameisen, Building Machine Learning Powered Applications, O'Reilly, 2020.

Reference Books:

1. Emily Robinson and Jacqueline Nolis, Build a career in Data Science, Manning, 2020.
2. Valliappa Lakshmanan, Sara Robinson and Michael Munn, Machine Learning Design Patterns, O'Reilly, 2021.
3. Andriy Burkov, Machine Learning Engineering, True Positive Inc, 2020.

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Program: B.Tech in Computer Science and Engineering (Data Science)	Final Year. B.Tech	Semester: VII
Course: Parallel Computing (DJ19DSC7011)		
Course: Parallel Computing Laboratory (DJ19DSL7011)		

Pre-requisite:

1. System Fundamentals

Objectives:

To familiarize students with the fundamental concepts, techniques and tools of parallel computing.

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

1. Understand different structures of Parallel Computers.
2. Apply parallel algorithms in problem solving.

Parallel Computing (DJ19DSC7011)		
Unit	**Description**	**Duration**
1	**Introduction:** Introduction to Parallel computing, Abstract model of serial & parallel computation, pipelining, data parallelism, control parallelism, scalability, topologies in processor organization, parallel computing design consideration, parallel algorithms & parallel architectures, speedup and efficiency, supercomputers.	**08**
2	**System Architecture:** Shared memory multiprocessors (UMA-Uniform memory Access), Distributed memory multiprocessors (NUMA- Non-Uniform memory Access), SIMD, Systolic processor, Cluster computing, Grid computing, Multicore Systems.	**06**
3	**Parallel Algorithms:** Introduction to parallel algorithms, parallel algorithm models, Decomposition Techniques, characteristics of tasks & interactions, mapping techniques for load balancing, methods for containing interaction overheads. Matrix multiplication, parallel reduction, parallel sorting: bubble, quick sort, Graph algorithm: Minimum spanning tree (prim's algorithm), Fast Fourier transform: serial algorithm, transpose algorithm.	**12**
4	**Parallel Programming:** Parallel programming models, point to point communication, synchronous and asynchronous communication, shared memory programming, message passing programming, MPI, PVM, Threads.	**08**
5	**Applications of Parallel Programming:** Issues and challenges, scope of parallel computing, applications in data mining, computer security and cryptography, medicine and human organ modelling.	**05**
	Total	**39**

Parallel Computing Laboratory (DJ19DSL7011)	
Exp.	**Suggested experiments**
1	To implement the parallel construct in OpenMP that creates a parallel region in a C++ code.
2	To write an OpenMP program for illustrating the Fork Join model.

3	To implement SPMD (Single Instruction Multiple Data) parallel program in OpenMP.
4	To write a simple OpenMP program to demonstrate the sharing of loop iteration by number of threads. (Take chunk size of 10).
5	To write an OpenMP program for finding prime numbers.
6	To write OpenMp program to demonstrate sharing of section work by performing arithmetic operations on one dimensional array.
7	To write OpenMP program to perform dot product of two one dimensional arrays.
8	To implement the program for Matrix addition and Matrix multiplication using OpenMp.
9	To implement the program for sorting algorithms (Bubble sort, Quick4 sort) in OpenMP.
10	To implement the program to create Minimum Spanning Tree by using Prim's algorithm.

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

*The Term Work will be calculated based on Laboratory Performance (15m) and Computer Based Assessment/Mini Project (10m).

Books Recommended:

Text books:

1. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, An Introduction to Parallel Computing: Design and Analysis of Algorithms, Pearson Publication, 2nd Edition, 2004
2. Steven Brawer, Introduction to Parallel Programming, Academic Press Inc, 1st Edition, 2000.
3. M.Sasikumar, Dinesh Shikhare, P. Ravi Prakash, Introduction to Parallel Processing, Prentice Hall, 2nd Edition, 2014.

Reference Books:

1. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, An Introduction to Parallel Computing: Design and Analysis of Algorithms, Pearson Publication, 2nd Edition, 2004.
2. Fayez Gebali, Algorithms and Parallel Computing, Wiley Series, 1st Edition, 2011.

Web Links

1. NPTEL course: https://archive.nptel.ac.in/courses/106/102/106102163/
2. Parallel Programming: https://hpc.llnl.gov/documentation/tutorials/introduction-parallel-computing-tutorial##Whatis

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Program: B.Tech in Computer Science and Engineering (Data Science)	Final Year. B.Tech	Semester: VII
Course: Advanced Computational Linguistics (DJ19DSC7012)		
Course: Advanced Computational Linguistics Laboratory (DJ19DSL7012)		

Pre-requisite:
1. Machine Learning- I and II
2. Computational Linguistics

Objectives:

To teach machine learning and deep Learning techniques to build Computational models for real world applications.

Outcomes: On completion of the course, the learner will be able to:
1. Apply classification techniques on linguistic data.
2. Apply machine Learning and deep learning techniques to build language model.
3. Develop applications based on natural language processing.

Advanced Computational Linguistics (DJ19DSC7012)		
Unit	**Description**	**Duration**
1	**Text Classification:** Text classification definition and datasets, Generative text classifiers (naive Bayes) Discriminative text classifiers (logistic regression), Bag-of-words Generative Classifier, BOW Discriminative Model , Multi-class Classification: Softmax, Gradient Descent, Statistical significance testing, Dataset understanding and creation.	**06**
2	**Language models using Deep Learning Architectures:** Language Modelling Problem Definition, Count-based Language Models, Measuring Language Model Performance: Accuracy, Likelihood, and Perplexity, Log-linear Language Models, Recurrent Networks: RNNs as Language, RNNs for Sequence Classification, Stacked and Bidirectional RNNs, Managing Context in RNNs: LSTMs and GRUs, Self-Attention Networks: Transformers, Transformers as Autoregressive Language Models.	**08**
3	**Machine Translation and Encoder-Decoder Models:** Encoder-Decoder with RNNs, Conditioned Generation and Search, Ensembling, Evaluation, Types of Data to Condition On Attention mechanism , Beam Search, Encoder-Decoder with Transformers, Some practical details on building MT systems ,MT Evaluation ,Bias and Ethical Issues Improvements to Attention, Specialized Attention Varieties.	**09**
4	**Multi-task, Multi-domain, and Multi-lingual Learning:** Pre-training Methods: Simple overview of multi-task learning, Sentence embedding's, BERT and variants, Other language modelling objectives Multi-task, Multi-domain, and Multi-lingual Learning: Multi-task Learning, Domain Adaptation and Robustness, Multi-lingual Learning Prompting, Sequence-to-sequence Pre-training: Prompting Methods, Sequence-to-sequence Pre-training, Prompt Engineering, Answer Engineering, Multi-prompt Learning, Prompt-aware Training Method.	**08**

5	**Information Extraction:** Relation Extraction, Relation Extraction Algorithms, Extracting Times, Extracting Events and their Times, Template Filling.	
	Question Answering: Information Retrieval, IR-based Factoid Question Answering, Entity Linking, Knowledge-based Question Answering, Using Language Models to do QA, Classic QA Models, Evaluation of Factoid Answers.	**06**
	Total	**39**

Advanced Computational Linguistics Laboratory (DJ19DSL7012)	
Exp.	**Suggested experiments**
1	Implement a Spam classifier using Naïve Bayes classifier
2	Implement a Sentiment Analysis on linguistic data
3	Implement Fake News Classifier using LSTM-Deep Learning Model
4	Implement Information Retrieval for extracting Text from Webpages and Image
5	Implement Language translator using Encoder Decoder model
6	Implement Document Classifier on multi-category dataset
7	Implement text Summarization using BERT
8	Implement Spelling Check, Spelling Correction and Auto complete using Language models
9	Implement Question Answering System using Deep Learning
10	Mini Project

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

*The Term Work will be calculated based on Laboratory Performance (15m) and Computer Based Assessment/Mini Project (10m).

Books Recommended:

Text books:

1. Jurafsky and Martin, Speech and Language Processing, Prentice Hall, 3rd Edition, 2020.
2. Uday Kamath, Deep Learning for NLP and Speech Recognition, 1st Edition, 2019.

Reference Books:

1. Jelinek, F., Statistical Methods for Speech Recognition, The MIT Press, 2022.
2. Yuli Vasiliev, Natural Language Processing with Python and spaCy - A Practical Introduction, No Starch Press, 2022.
3. Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana, Practical Natural Language Processing: A Comprehensive Guide to Building Real-World NLP Systems, O'Reilly, 1st Edition, 2020.
4. Lewis Tunstall, Leandro von Werra, Thomas Wolf, Natural Language Processing with Transformers, O'Reilly Media, Inc, 2022.
5. Ashish Bansal, Advanced Natural Language Processing with Tensor Flow 2, Packt Publishing

Ltd, 2022

Web Links

1. Virtual Lab: - https://nlp-iiith.vlabs.ac.in/
2. Virtual Lab:
   http://vlabs.iitb.ac.in/vlabsdev/vlab_bootcamp/bootcamp/The_Bing_Bang_Nerds/index.html
3. Nptel Course: - https://nptel.ac.in/courses/106105158

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Program: B.Tech in Computer Science and Engineering (Data Science)	Final Year. B.Tech	Semester: VII
Course: IoT Network Enterprise (DJ19DSC7013)		
Course: IoT Network Enterprise Laboratory (DJ19DSL7013)		

Pre-requisite:
1. Analog and Digital Communication,
2. Embedded Systems and RTOS.

Objectives:
1. Comprehend and differentiate between wired & wireless networks and understand the TCP/IP suite.
2. Differentiate & evaluate existing power management mechanisms for power constrained applications in IoT.
3. Differentiate & discriminate between existing wireless topologies, technologies & protocols as per requirement.
4. Comprehend the security challenges for IoT Domain & evaluate existing SaaS, PaaS and IaaS services.

Outcomes: On completion of the course, the learner will be able to:
1. Outline application & link layer services for wired and wireless applications.
2. Design & optimize – sensors, power modules and actuation for constrained environment applications.
3. Comprehend and evaluate the mechanism needed for network security of application environment.
4. Demonstrate the use of SaaS, PaaS and IaaS services.

IoT Network Enterprise (DJ19DSC7013)		
Unit	**Description**	**Duration**
1	**Introduction to Computer Networks:** Network Protocol Stack- OSI & TCP/IP Model, IoT Enterprise Architecture – Switches, Routers & Gateways, IP Addressing, Sub-netting & Routing (OSPF, RIP, EIGRP & BGP). ARP, DHCP, MODBUS-TCP, SMTP (POP3 & IMAP), HTTPS, DNS DDNS & FTP Protocols.	14
2	**Sensors Networks:** Definition, Types of Sensors, Types of Actuators, Examples and Working, IoT Development Boards: Arduino IDE and Board Types, RaspberriPi Development Kit, RFID Principles and components, Wireless Sensor Networks: History and Context, The node, Connecting nodes, Networking Nodes, WSN and IoT.	06
3	**Wireless Technologies for IoT:** WPAN Technologies for IoT: IEEE 802.15.4, Zigbee, HART, NFC, Z-Wave, BLE, Bacnet, Modbus. IP Based Protocols for IoT: IPv6, 6LowPAN, RPL, REST, AMPQ, CoAP, MQTT. Edge connectivity and protocols.	08

4	**Cybersecurity:** Network Security- Packet Sniffing, ARP and IP Spoofing, Denial of Service attacks, Firewalls & Intrusion Prevention System, Block Ciphers- Data Encryption Standard- DES, Advanced Encryption Standard- AES & RSA Algorithm. Cryptographic Hashes & Message Digest – MD5, SHA, CMAC, HMAC. Internet Security Protocols – SSL, TLS and IPSec.	**10**
5	**Cloud Services:** Virtualization – Taxonomy & Implementation of levels of Virtualization, Cloud Computing Architecture – Exploring AWS components: EC2, and S3 services.	**04**
	Total	**42**

IoT Network Enterprise Laboratory (DJ19DSL7013)	
Exp.	**Suggested experiments**
1	Device Functionalities using Cisco Packet Tracer - Implementing Hubs, Switches & Routers
2	IP addressing & Multi-path routing using Wired & Wireless Protocols (RIP & OSPF)
3	Understanding Load Balancing & Server Load, Ethernet delay using Riverbed Modeler
4	Implementing MQTT (Smart utility meter - Paho MQTT client & Mosquitto Broker) with Raspberry Pi
5	Implementing LoRa with MQTT & using AWS services as broker-storage
6	Using YABE, BACnet & MQTT box to report IAQ sensor data – How to write reports for functional testing of IoT gateways
7	Cybersecurity: Using Wireshark & NMAP for packet tracing in promiscuous & non-promiscuous mode using Packet Filters and demonstrate ARP Spoofing and Port Scanning – Reconnaissance tools
8	Implement a hashing-cryptography mechanism using Pycryptodome
9	Create and run a Virtual Machine on a hosted Hypervisor – Oracle Virtualbox
10	Explore AWS EC2, S3 & Network Security Services provided by AWS

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

*The Term Work will be calculated based on Laboratory Performance (15m) and Computer Based Assessment/Mini Project (10m).

Books Recommended:

Text books:

1. Ames Kurose, Keith Ross, Computer Networking: A Top - Down Approach, 6th Edition, 2017.
2. Arshdeep Bahga and Vijay Madisetti, Internet of Things: A Hands-on Approach, Universities Press, 1st Edition, 2015.

Reference Books:

1. Raj Kamal, Internet of Things: Architecture and Design Principles, McGraw Hill Education, 1st Edition, 2017
2. David Hanes, Gonzalo Salgueiro, IoT Fundamentals Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 1st Edition, 2017.

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Program: B.Tech in Computer Science and Engineering (Data Science)	Final Year. B.Tech	Semester: VII
Course: Adversarial Machine Learning (DJ19DSC7014)		
Course: Adversarial Machine Learning Laboratory (DJ19DSL7014)		

Pre-requisite:

1. Mathematics for Intelligent System
2. Machine Learning – I
3. Information Security

Objectives:

Introduces students to adversarial attacks on machine learning models and defense against the attacks. The particular focus is on adversarial examples in deep learning models, due to their prevalence in modern machine learning applications. The course also provides an overview of adversarial attacks against machine learning models used in cybersecurity applications, including malware detection and classification, network intrusion detection, spam filtering, URL detection.

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

1. Outline the different categories of adversarial attacks and defenses against conventional machine learning models and deep learning models.
2. Identify the unique characteristics of adversarial machine learning attacks in the cybersecurity domain.
3. Understand the basics of adversarial privacy attacks and privacy-preserving defense methods.

**Adversarial Machine Learning (DJ19DSC7014)**	
Unit	**Description**	**Duration**
1	**Machine Learning Preliminaries**: Supervised Learning, Supervised Learning in Adversarial Settings, Unsupervised Learning, Unsupervised Learning in Adversarial Settings, Reinforcement Learning in Adversarial Settings, Categories of Attacks on Machine Learning. **Deep Learning Overview:** Machine learning basics, Introduction to deep learning, Elements of neural networks (NNs), Training NNs, NN architectures. **Introduction to Adversarial Machine Learning**: Adversarial Machine Learning Taxonomy and History, Statistical Machine Learning, A Framework for Secure Learning: Analyzing the Phases of Learning, Framework, Security Analysis, Exploratory Attacks, Causative Attacks.	06
2	**Causative Attacks on Machine Learning:** Availability Attack Case Study: SpamBayes, The SpamBayes Spam Filter, Threat Model for Spam Bayes, The Reject on Negative Impact (RONI) Defense. **Causative Attacks on Machine Learning:** Integrity Attack Case Study: PCA Detector, PCA Method for Detecting Traffic Anomalies, Corrupting the PCA Subspace, Corruption-Resilient Detectors.	04

3	**Evasion Attacks:** Evasion Attacks against White box: Fast gradient sign method (FGSM) attack. Projected gradient descent (PGD) attack, DeepFool attack. **Black box adversarial attacks:** Query based attacks, Transfer based attacks (or transferability attacks, Attacks on Real Models. **Defenses Against Evasion Attacks:** Adversarial examples detection, Gradient masking/obfuscation, Robust optimization.	12
4	**Adversarial Machine Learning in Cyber Security:** Malware Detection and Classification: Machine Learning in cybersecurity, Taxonomy of AML attacks in cybersecurity, Malware detection and classification, Adversarial attacks on ML-based malware classifiers, Malware Detection and Classification. **Network Intrusion Detection:** Network intrusion detection, Datasets for network intrusion detection, Anomaly detection with Machine Learning, Adversarial attacks on ML-based NIDS.	12
5	**Adversarial Machine Learning Challenges:** Discussion and Open Problems, Unexplored Components of the Adversarial Game, Development of Defensive Technologies	05
	Total	39

Adversarial Machine Learning Laboratory (DJ19DSL7014)	
Exp.	**Suggested experiments**
1	Implement non-targeted white-box evasion attacks against the deep learning models: Fast Gradient Sign Method (FGSM), and Projected Gradient Descent (PGD).
2	Implement targeted white-box evasion attacks against the deep learning models.
3	Implement a PGD attack on the DL model ResNet50, and investigate if the adversarial examples transfer to the other conventional ML models.
4	Implement a non-targeted PGD attack on the logistic regression model for the set of 120 images.
5	Implement adversarial defenses for white-box evasions attacks against deep learning-based classification models.
6	Get familiar with ML classification models used in cybersecurity applications and implement adversarial attacks against such models.
7	Attacks on ML systems for Network Intrusion Detection
8	Attacks on ML systems for Malware Detection
9	ML systems for Spam Filtering
10	Mini Project

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

*The Term Work will be calculated based on Laboratory Performance (15m) and Computer Based Assessment/Mini Project (10m).

Books Recommended:

Text books:
1. Anthony D. Joseph, Blaine Nelson, Adversarial Machine Learning, Cambridge University Press, 2019, ISBN: 978-1-107-04346-6.

2. Zhang, Z. Lipton, and A. Smola. Dive into Deep Learning, 1st Edition, 2023.
3. Soma Halder, Hands-On Machine Learning for Cybersecurity: Safeguard your system by making your machines intelligent using the Python ecosystem, Packt Publishing, 1st Edition, 2018.

Web Links
1. Goodfellow (2014) Explaining and Harnessing Adversarial Examples)
2. Carlini (2017) Towards Evaluating the Robustness of Neural Networks
3. Brendel (2017) Decision-Based Adversarial Attacks: Reliable Attacks Against Black-Box Machine Learning Models
4. Bhagoji (2017) Exploring the Space of Black-box Attacks on Deep Neural Networks
5. Xu (2019) Adversarial Attacks and Defenses in Images, Graphs and Text: A Review
6. Tramer (2018) Ensemble Adversarial Training: Attacks and Defenses
7. Rosenberg (2021) Adversarial Machine Learning Attacks and Defense Methods in the Cyber Security Domain
8. Severi (2021) Explanation-Guided Backdoor Poisoning Attacks Against Malware Classifiers
9. Kuleshov (2018) Adversarial Examples for Natural Language Classification Problems (pdf)
10. Erba (2019) Constrained Concealment Attacks against Reconstruction-based Anomaly Detectors in Industrial Control Systems (pdf)

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Program: B.Tech in Computer Science and Engineering (Data Science)	Final Year. B.Tech	Semester: VII
Course: **Product Life Cycle Management (DJ19ILO7011)**		

Pre-requisite:

1. Knowledge of basic concepts of Management

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

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

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Product Life Cycle Management (DJ19ILO7011)		
Unit	Description	Duration
1	**Introduction to Product Lifecycle Management (PLM):** Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM	10
2	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	08

3	**Product Data Management (PDM):** Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation **Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modelling and simulations in Product Design, Examples/Case studies	08
4	**Integration of Environmental Aspects in Product Design:** Sustainable Development Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design.	08
5	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitationsof Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Frameworkfor LCCA, Evolution of Models for Product Life Cycle Cost Analysis.	08
	Total	42

Books Recommended:

Text books:

1. John Stark, Product Lifecycle Management: Paradigm for 21st Century Product Realization, Springer-Verlag, 2004.
2. Guido La Rosa, Antonino Risitano, Taylor & Francis, Product Design for the environment-A life cycle approach, Fabio Giudice, 2006.

Reference Books:

1. Saaksvuori Antti, Immonen Anselmie, Product Life Cycle Management‖, Springer, Dreamtech, 2009.
2. Michael Grieve, Product Lifecycle Management: Driving the next generation of lean thinking, Tata McGraw Hill, 2006.
3. François Villeneuve, Luc Mathieu, Max Giordano, Product Life-Cycle Management: Geometric Variations Wiley, 2010.

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Program: B.Tech in Computer Science and Engineering (Data Science)	Final Year. B.Tech	Semester: VII
Course: **Management Information System (DJ19ILO7012)**		

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built.
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage.
4. Identify the basic steps in systems development.

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

1. Explain how information systems Transform Business.
2. Identify the impact information systems have on an organization.
3. Describe IT infrastructure and its components and its current trends.
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making.
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses.

Management Information System (DJ19ILO7012)		
Unit	**Description**	**Duration**
1	**Foundation Concepts:** Information Systems in Business, Functional Area Information System**,** The Components of Information Systems**,** Impact of IT on organizations and society, Organizational Strategy, Information systems for strategic advantage.	**05**
2	**Information Technologies:** Hardware and Software **Computer Systems:** End User and Enterprise Computing **Computer Peripherals:** Input, Output, and Storage Technologies **Application Software:** End User Applications **System Software:** Computer System Management **Data Resource Management:** Technical Foundations of Database Management, Managing Data Resources, Big data, Data warehouse and Data Marts**,** Knowledge Management **Networks:** The Networked Enterprise (Wired and wireless), Pervasive computing, Cloud Computing models	**08**
3	**MIS Tools and applications for Decision making:** ERP and ERP support of Business Process Reengineering, **Business intelligence (BI):** Managers and Decision Making, BI for Data analysis and Visualization **Artificial Intelligence Technologies in Business**	**08**
4	**Security and Ethical Challenges:** Security, Ethical, and Societal Challenges of IT Security Management of Information Technology.	**06**

5	**Social Computing (SC):** Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C, Mobile commerce.	**07**
6	**Information System within Organization:** Acquiring Information Systems and Applications: Various System development life cycle models. **Enterprise and Global Management of Information Technology:** ManagingInformation Technology, Managing Global IT.	**08**
	Total	**42**

Books Recommended:

Reference Books:

1. James A O'Brien, George M., Ramesh Behl, Management Information Systems, 11th Edition, Tata McGraw Hill, 2019.
2. Kelly Rainer, Brad Prince, Management Information Systems, 2nd Edition, Wiley, 2013.
3. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Edition, Prentice Hall, 2007.
4. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008.

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Program: B.Tech in Computer Science and Engineering (Data Science)	Final Year. B.Tech	Semester: VII
Course: Operations Research (DJ19ILO7013)		

Pre-requisite:
1. Basic Knowledge of Algebra
2. Probability and Statistics

Objectives:
1. To formulate a real-world decision problem as a mathematical programming model.
2. To learn the mathematical tools that are employed to solve mathematical programming models.

Outcomes: On completion of the course, the learner will be able to:
1. **Convert** a real-world problem in to a Linear Programming Problem and analyse the solution obtained using Simplex method or other algorithms.
2. **Identify** real-world problems as Transportation Problem and Assignment Problem and Solve the decision problem by choosing appropriate algorithm.
3. **Identify** the decision situations which vary with time and analyse them using principle of dynamic programming to real life situations.
4. **Explain** reasons of formation of queues, classify various queuing systems and apply parameters defined for various queuing systems for decision making in real life situations.
5. **Understand** the concept of decision making in situation of competition and recommend strategies in case of two-person zero sum games.
6. **Describe** concept of simulation and apply Monte Carlo Simulation technique to systems such as inventory, queuing and recommend solutions for them.
7. **Understand** need for right replacement policy and determine optimal replacement age.

Operations Research (DJ19ILO7013)		
Unit	**Description**	**Duration**
1	**Introduction to Operations Research:** Concept of decision making. Definition of OR. Formulation of decision problem as OR model, Concept of Optimization, **Linear Programming Problem:** Mathematical Formulation. Finding optimal solution - Graphical method, Simplex Method, Big M-method, Two Phase Method. Duality, Primal – Dual construction, Symmetric and Asymmetric Dual. Dual Simplex Method.	10
2	**Assignment Problems:** Mathematical Formulation, Finding optimal solution - Hungarian Method **Transportation problem:** Mathematical Formulation, Finding initial basic feasible solution – Northwest corner rule, row minima, column minima, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. Improving the solution.	08

3	**Dynamic Programming**: Bellman's Principle of optimality - Applications of dynamic programming- Employment smoothening problem, capital budgeting problem, shortestpath problem, cargo loading problem	**06**
4	**Queuing Models:** Characteristics of queuing models. Single Channel – Single and multi phase servers, Poisson arrivals, exponential service time - with infinite population and finite population models – with infinite and finite capacity. Multichannel – Single phase server - Poisson arrivals, exponential service time with infinite population. **Game Theory:** Introduction. Minimax & Maximin Criterion and optimal strategy. Solution of games with saddle points, rectangular games without saddle points - 2 x 2 games, dominance principle. Approximate methods - Iterative method, m x 2 & 2 x n games -Graphical method and method of sub-games. Expressing game as LPP.	**10**
5	**Simulation:** Definition. Types of simulation models. Monte Carlo simulation technique. Applications of simulation - Inventory and Queuing problems. Simulation Languages. **Replacement Models:** Replacement of items that deteriorate with time - when money value is not counted and counted, Replacement of items that fail suddenly – individualand group replacement policy.	**08**
	Total	**42**

Books Recommended:

Text books:

1. Operations Research, Sharma J. K., Trinity Press.
2. Operations Research, Gupta P. K., Hira D. S., S. Chand Limited.

Reference Books:

1. Operations Research - An Introduction; Taha, H.A.; Prentice Hall
2. Operations Research: Principles and Practice; Ravindran, A, Phillips, D. T and Solberg, J. J.; John Willey and Sons
3. Introduction to Operations Research; Hiller, F. S. and Liebermann, G. J.; Tata McGraw Hill
4. Operations Research Principles and Practice; Pradeep Prabhakar Pai; Oxford University Press
5. Operations Research, R. Panneerselvam, PHI Publications.
6. Operations Research, A. M. Natarajan, P. Balasubramani, A. Tamilarasi, Pearson Education.
7. Operations Research; Kanti Swarup, P. K. Gupta and Man Mohan; Sultan Chand & Sons.

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Program: B.Tech in Computer Science and Engineering (Data Science)	Final Year. B.Tech	Semester: VII
Course: Cyber Security and Laws (DJ19ILO7014)		

Objectives:

1. To understand and identify different types cybercrime and cyber offences.
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

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

1. Understand the different types of cybercrime and security issues E Business.
2. Analyses different types of cyber threats and techniques for security management.
3. Explore the legal requirements and standards for cyber security in various countries to regulate cyberspace.
4. Impart the knowledge of Information Technology Act and legal frame work of right to privacy, data security and data protection.

Cyber Security and Laws (DJ19ILO7014)		
Unit	Description	Duration
1	**Introduction to Cybercrime**: Cyber Crime, Cyber Law, Cyber Security, History of Cyber Crime, Hacking, Data Theft, Cyber Terrorism, Virus & Worm's, Email Bombing, Pornography, online gambling, Forgery, Web Defacements, Web Jacking, Illegal online Selling, Cyber Defamation, Software Piracy, Electronics/ Digital Signature, Phishing, Password Cracking, Key loggers and Spywares, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing Identity Theft (ID Theft) **Cyber offenses:** How criminal plan the attacks, Social Engineering, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector	12
2	**Cyber Threats Analysis:** Knowledge of Dynamic and Deliberate Targeting Knowledge of Indications and Warning Knowledge of Internal Tactics to Anticipate and/or, Emulate Threat Capabilities and Actions Knowledge of Key Cyber Threat Actors and their Equities Knowledge of Specific Target Identifiers and Their Usage **Cyber Security Management:** Knowledge of Emerging Security Issues, Risks, and Vulnerabilities	08
3	**Electronic Business and legal issues:** Evolution and development in Ecommerce, Policy Frameworks for Secure Electronic Business, paper vs paper less contracts, E-Commerce models- B2B, B2C, E security. E-Payment Mechanism; Payment through card system, E-Cheque, E-Cash, E-PaymentThreats & Protections, Security for E-Commerce.	06

4	**Indian IT Act:** Cyber Crime and Criminal Justice, Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments **Security aspect in cyber Law:** The Contract Aspects in Cyber Law, The Security Aspect of Cyber Law, The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law, The Criminal Aspectin Cyber Law	08
5	**Security Industries Standard Compliances:** IT Security v/s IT Compliance, Cyber Security Standards, critical security controls for cyber security, GRC (Governance, Risk Management, andCompliance), SOX, GLBA, HIPAA, ISO/IEC 27001, NIST Cyber Security Framework (CSF), PCI-DSS. OWASP Top Ten Project, GDPR (General Data Protection Regulation), NIST (National Institute of Standards and Technology), CIS Controls (Center for Internet SecurityControls)	08
	Total	**42**

Books Recommended:

Reference Books:

1. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi.
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi.
3. The Information Technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. E-Commerce Security and Privacy", Anup K. Ghosh, Springer Science and Business Media, 2012.
5. Izzat Alsmadi, The NICE Cyber Security Framework Cyber Security Intelligence and Analytics, Springer.
6. Cyber Law & Cyber Crimes, Advocate Prashant Mali; Snow White Publications, Mumbai
7. Nina Godbole, Information Systems Security, Wiley India, New Delhi.
8. Kennetch J. Knapp, Cyber Security &Global Information Assurance Information Science Publishing.
9. William Stallings, Cryptography and Network Security, Pearson Publication
10. Websites for more information is available on: The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
11. Website for more information, A Compliance Primer for IT professional: https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

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Program: B.Tech in Computer Science and Engineering (Data Science)	Final Year. B.Tech	Semester: VII
Course: **Personal Finance Management (DJ19ILO7015)**		

Pre-requisite:
1. Basic Knowledge of Algebra
2. Probability and Statistics

Objectives:
1. To create awareness and educate consumers on access to financial services.
2. To make the students understand the basic concepts, definitions and terms related to direct taxation.
3. To help the students compute the Goods and Service Tax (GST) payable by a supplier after considering the eligible input tax credit.
4. To familarise the students with microfinance for accelerating the expansion of local microbusinesses.

Outcomes: On completion of the course, the learner will be able to:
1. Use a framework for financial planning to understand the overall role finances play in his/her personal life.
2. Compute income from salaries, house property, business/profession, capital gains and income from other sources.
3. Compute the amount of CGST, SGST and IGST payable after considering the eligible input tax credit.
4. Understand how Microfinance can help in financial inclusion.

Personal Finance Management (DJ19ILO7015)		
Unit	**Description**	**Duration**
1	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. Financial Instruments and Financial Markets, Financial inclusion. **Introduction to Personal Finance** Person Financial Planning in Action, Money Management Skills, Taxes in Your Financial Plan, Savings and Payment Services. Consumer Credit: Advantages, Disadvantages, Sources and Costs.	**07**
2	**Personal Financial Management:** **Loans:** Home, Car, Education, Personal, Loan against property and Jewel loan. **Insurance:** Types of Insurance – ULIP and Term; Health and Disability IncomeInsurance, Life Insurance. **Investment:** Investing Basics and Evaluating Bonds, Investing in Stocks and Investingin Mutual Funds, Planning for the Future.	**07**
3	**Income Tax:** **Income Tax Act Basics**- Introduction to Income Tax Act, 1961	

	Heads of Income and Computation of Total Income and Tax Liability- Heads of Income and Computation of Total Income under various heads, Clubbing Provisions, Set off and Carry forward of Losses, Deductions, Assessment of Income and tax liability of different persons. **Tax Management, Administrative Procedures and ICDS -** TDS, TCS and Advance Tax Administrative Procedures, ICDS.	**08**
4	**Goods and Services Tax:** GST Constitutional framework of Indirect Taxes before GST (Taxation Powers of Union & State Government); Concept of VAT: Meaning, Variants and Methods; MajorDefects in the structure of Indirect Taxes prior to GST; Rationale for GST; Structure of GST (SGST, CGST, UTGST & IGST); GST Council, GST Network, State Compensation Mechanism, Registration. **Levy and Collection of GST:** Taxable event- "Supply" of Goods and Services; Place of Supply: Within state, Interstate, Import and Export; Time of supply: Valuation for GST- Valuation rules, taxability of reimbursement of expenses; Exemption from GST: Small supplies and Composition Scheme: Classification of Goods and Services	**10**
5	**Introduction to Micro – finance:** Micro-Finance: Definitions, Scope & Assumptions, Types of Microfinance, Customersof Micro-finance, Credit Delivery Methodologies, SHG concept, origin, Formation & Operation of Self Help Groups (SHGs). **Models in Microfinance -** Joint Liability Groups (JLG), SHG Bank Linkage Model and GRAMEEN Model: Achievements & Challenges, **Institutional Mechanism:** Current Challenges for Microfinance, Microfinance Institutions (MFIs): Constraints & Governance Issues, Institutional Structure of Microfinance in India: NGO-MFIs, NBFC-MFIs, Co-operatives, Banks, Microfinance Networks and Associations; Demand& Supply of Microfinance Services in India, Impact assessment and social assessments of MFIs,	**10**
	Total	**42**

Books Recommended:

Reference Books:

1. Banking and Financial Sector Reforms in India , by Asha Singh, M.S. Gupta, Serials Publication.
2. Indian Banking Sector: Essays and Issues (1st) , by M.S. Gupta & J.B. Singh, Serials Publication.
3. Basics Of Banking & Finance , by K.M. Bhattacharya O.P. Agarwal , Himalaya Publishing House
4. Agricultural Finance And Management, by S. Subba Reddy , P. Raghu Ram .
5. The Indian Financial System And Development , by Dr.Vasant Desai, Himalaya Publishing House; Fourth Edition
6. Income Tax Management , Simple Way of Tax Management, Tax Planning and Tax Saving
7. , By Sanjay Kumar Satapathy

8. Direct Tax System Income Tax by Dr. R. K. Jain, SBPD Publications.
9. Simplified Approach to GST Goods and Services Tax, By S K Mishra , Educreation Publishing.
10. Introduction To Microfinance , By Todd A Watkins , World Scientific Publishing Company

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Program: B.Tech in Computer Science and Engineering (Data Science)	Final Year. B.Tech	Semester: VII
Course: **Energy Audit and Management (DJ19ILO7016)**		

Objectives:

1. To understand the importance of energy security for sustainable development and the fundamentals of energy conservation.
2. To identify and describe the basic principles and methodologies adopted in energy audit of a utility
3. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management.
4. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

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

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of a utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities.
5. To analyze the data collected during performance evaluation and recommend energy saving measures.

Energy Audit and Management (DJ19ILO7016)		
Unit	**Description**	**Duration**
1	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms,Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance.	**05**
2	**Energy Audit:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, matching energy use to requirement, Maximizing system efficiencies,Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring & targeting, Energy audit instruments. Technical and economic feasibility, Classification of energy conservation measures. Safety considerations during energy audit. **Financial analysis techniques:** Simple payback period, NPV, Return on investment (ROI) Internal rate of return (IRR).	**10**
3	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. Energy efficiency measures in lighting system, lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in waterpumps, compressor, fan	**10**

	and blower. industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
4	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Steam leakages, Steam trapping, Condensate and flash steam recovery system. Waste heat recovery, use of insulation- types and application. Energy conservation opportunities in: Boiler system. Refrigeration system and HVAC system.	10
5	**Energy conservation in Buildings**: Energy Conservation Building Codes (ECBC):Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources, Energy sources and energy management in electric vehicles.	07
	Total	**42**

Books Recommended:

Reference Books:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science.
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System.
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons.
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B. Smith, Pergamon Press.
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press.
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press.
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Prepared by   Checked by   Head of the Department   Principal

Program: B.Tech in Computer Science and Engineering (Data Science)	Final Year. B.Tech	Semester: VII
Course: Disaster Management and Mitigation Measures (DJ19ILO7017)		

Objectives:

1. To provide basic understanding hazards, disaster and various types and categories of disaster occurring around the world.
2. To identify extent and damaging capacity of a disaster.
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand roles and responsibilities of individual and various organization during and after disaster.
5. To appreciate the significance of GIS, GPS in the field of disaster management.
6. To understand the emergency government response structures before, during and after disaster.

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

1. Know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Know the institutional framework and organization structure in India for disaster management and get acquainted with government policies, acts and various emergency laws.
3. Get to know the simple dos and don'ts in such extreme events and build skills to respond accordingly.
4. Understand the importance of disaster prevention and various mitigation measure with the exposure to disasters hotspots across the globe.

Disaster Management and Mitigation Measures (DJ19ILO7017)		
Unit	**Description**	**Duration**
1	**General Information about Disaster:** Brief concept of Hazards, definition and types of Disasters – Natural, Man-made, and hybrid, Groups of Disasters- Natural and Technological, global Scenario, Significance of studying various aspects of disasters, effects of disasters, India's vulnerability to disasters, Impact of disaster on National development. Study of Natural disasters: Flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion etc. Study of Human/Technology Induced Disasters: Chemical, Industrial and Nuclear disasters, Internally displaced persons, road and train accidents Fire Hazards, terrorism, militancy, Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	10
2	**Disaster Management:** Brief Introduction, Disaster management cycle, Evolution of Disaster and Disaster management in India, Disaster management acts, policies and guidelines, laws of emergencies etc.	08

	Prior, During and Post disaster management activities: (Preparedness, strengthening emergency centers, Logistics, optimum resource management, emergency response and relief, Training, Public awareness, Research, Reconstruction of essential services and livelihood restoration.	
3	**Institutional framework and Mechanism for disaster management in India:** Institutions in India for dealing with various disasters, Organizational structure, functions and responsibilities of National Institute of Disaster Management (NIDM) and Nationaldisaster management authority (NDMA) in India, roles and responsibilities of central and state government during and after disaster, NGO's involved in disasters and their task, Jobscarried out by armed forces. Financial Relief During disaster (State, National and International Disaster Assistance)	08
4	**Disaster risk reduction and Mitigation Measures:** Need of disaster prevention and mitigation, mitigation guiding principles, challenging areas, structural and non-structural measures for disaster risk reduction. Mitigation measures for flood, earthquake, cyclone monitoring, air quality, water quality, climate change, land use, winter storms and aquatic biology etc. Use of information management, GIS, GPS and remote sensing Mitigation measure.Do's and don'ts in case of disasters and effective implementation of relief aids.	08
5	**Case studies on disaster (National /International):** Case study discussion of Hiroshima – Nagasaki (Japan), India – Tsunami (2004) , Bhopal gas tragedy, Kerala and Uttarakhand flood disaster, Cyclone Phailin (2013), Fukushima Daiichi nuclear disaster (2011), 26th July 2005 Mumbai flood, Chernobyl meltdown and so on. (Discuss case studies on disaster with respect to reason for the disaster, incidents, effects of disaster, present scenario and safety measures taken)	08
	Total	**42**

Books Recommended:

Reference Books:

1. Disaster Management, by Harsh K.Gupta, Universities Press Publications (2003).
2. Disaster Management: An Appraisal of Institutional Mechanisms in India, by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. Introduction to International Disaster Management, by Damon Copolla, Butterworth Heinemann Elsevier Publications (2015).
4. Disaster Management Handbook, by Jack Pinkowski, CRC Press, Taylor and Francis group (2008).
5. Disaster management & rehabilitation, by Rajdeep Dasgupta, Mittal Publications, New Delhi (2007).
6. Natural Hazards and Disaster Management, Vulnerability and Mitigation, by R B Singh, Rawat Publications (2006).
7. Concepts and Techniques of GIS, by C.P.Lo Albert, K.W. Yonng, Prentice Hall (India) Publications (2006).
8. Risk management of natural disasters, by Claudia G. Flores Gonzales, KIT Scientific Publishing (2010).

9. Disaster Management – a disaster manger's handbook, by W. Nick Carter, Asian Development Bank (2008).

10. Disaster Management in India, by R. K. Srivastava, Ministry of Home Affairs, GoI, New Delhi (2011)

11. The Chernobyl Disaster: Legacy and Impact on the Future of Nuclear Energy, by Wil Mara, Marshall Cavendish Corporation, New York, 2011.

12. The Fukushima 2011 Disaster, by Ronald Eisler, Taylor & Francis, Florida, 2013.

13. (Learners are expected to refer reports published at national and international level and updated information available on authentic web sites)

Program: B.Tech in Computer Science and Engineering (Data Science)	Final Year. B.Tech	Semester: VII
Course: Science of Well-being (DJ19ILO7018)		

Objectives:

1. To create consciousness about importance of holistic health and physical as well as mental well-being.
2. To make learners aware of the concepts of Happiness, Gratitude, Self-Compassion, Empathy etc.
3. To introduce the learners to the means of mental and physical well-being, ill effects of mal-practices like alcoholism, smoking etc.
4. To equip the learners to manage and cope up with stress in their daily living.

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

1. Describe concepts of holistic health and well-being, differentiate between its true meaning and misconceptions and understand the benefits of well-being.
2. Recognize meaning of happiness, practice gratitude and self-compassion and analyze incidents from one's own life.
3. Understand the causes and effects of stress, identify reasons for stress in one's own surrounding and self.
4. Recognize the importance of physical health and fitness, assess their life style and come up with limitations or effectiveness.
5. Inspect one's own coping mechanism, assess its effectiveness, develop and strategize for betterment and execute it.

	Science of Well-being (DJ19ILO7018)	
Unit	**Description**	**Duration**
1	**Health and well-being:** The concept of health, dimensions of health, the notion of well-being, various facets of well-being, relation between health and well-being. Concept of holistic health, its principles and importance, concept and benefits of holistic care, misconceptions about holistic health approach, the application of a true holistic approach to our well-being.	**06**
2	**Concepts of happiness:** Happiness: what is it and how do we measure it? Philosophical perspectives on happiness, Happiness: Nature or Nurture? Happiness in the modern world: impediments and accelerators, Narrow vs. Broad Band Approaches to Happiness, Benefits of Happiness, Self-Compassion and Gratitude. Misconceptions of happiness.	**08**
3	**Stress and mental health/well-being**: Nature and concept of stress, meaning and definitions of stress, types of stress, meaning of stressors, types of stressors, symptoms of stress, effects of stress, different models of stress. Sources of stress and how does stress cause illness, various sources of stress, delineate between external and internal sources of stress, differentiate between continuous and discrete stressors, the effects of these stressors on health and well-being, diversity of	**10**

	stressors and their health consequences, relation between stress and illness from different perspectives association between stress related physiological mechanisms and different illnesses.	
4	**Physical Well-being / Health management:** concept of health behaviours, dimensions of health behaviours. Health enhancing behaviors: Exercise and Weight control, application and importance of these health enhancing behaviours. Health protective behaviors and illness management: concept of illness management, effectiveness of illness management. Concept of Nutrition, Role of Nutrition, Components of Nutrition, concept of Malnutrition, Health compromising behaviours: Alcoholism, Smoking and its effects on health.	10
5	**Dealing with Difficult Times / Coping mechanisms:** The concept of chronic stress, Health and safety risks of chronic stress, Forms and Treatment of chronic stress, Coping with Acute and Chronic stress, theories of the stress-illness link, role of stress in mental disorders. Concept of coping, Ways of coping and stress management, basic knowledge about stress management, various techniques of stress management, stress management programs. Mental strengths and virtues, Hope, Optimism, Resilience – concept, pathways and models, Meditation and Self-introspection.	08
	Total	42

Books Recommended:

Textbooks:

1. The Science of well-being by Felicia Huppert, Nick Baylis, Barry Keverne; Oxford University Press
2. Health and Well-Being: Emerging Trends by S. Ojha, U. Rani Srivastava, Shobhna Joshi, Global Vision Publishing House
3. Positive psychology: The scientific and practical explorations of human strengths by Shane
4. J. Lopez, Jennifer Teramoto Pedrotti, Charles Richard Snyder; Sage Publications.

Reference Books:

1. The pursuit of happiness and the realization of sympathy: Cultural patterns of self, social relations, and well-being by Kitayama, S., & Markus, H. R, Culture and subjective well-being, The MIT Press.
2. Man Adapting by Dubos, R; New Haven: Yale University Press.
3. Happiness a history by McMahon D. M., Atlantic Monthly Press.
4. Well-being: The foundations of hedonic psychology by D. Kahneman & E. Diener & N. Schwarz, New York: Russell Sage
5. Selye H. The Stress of Life. New York; McGraw-Hill; 1984.

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Program: B.Tech in Computer Science and Engineering (Data Science)	Final Year. B.Tech	Semester: VII
Course: **Research Methodology (DJ19ILO7019)**		

Pre-requisites:
1. Basic Knowledge of Probability and Statistics.

Objectives:
1. To understand Research and Research Process
2. To acquaint learners with identifying problems for research and develop research strategies
3. To familiarize learners with the techniques of data collection, analysis of data and interpretation

Outcomes: On completion of the course, the learner will be able to:
1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings
5. Write report about findings of research carried out

Research Methodology (DJ19ILO7019)		
Unit	Description	Duration
1	**Basic Research Concepts** Meaning of research, Objectives of research, Types of research, Significance of research Research process	**07**
2	**Research Methodology:** Identification of research problem, Literature review, Formulation of hypothesis, Formulation of Research design.	**10**
3	**Research and Sample Design:** Meaning of research and sample design, Need of research design, Features of good research design, Important concepts, Different research designs, Types of sampling designs	**10**
4	**Data Collection and Data Analysis:** Types of data, Methods for collecting data: Experiments and surveys, Collection of primary and secondary data, Hypothesis testing and interpretation of Data	**10**
5	**Interpretation and Report Writing:** Interpretation and drawing conclusions on the research, Preparation of the report, Ethical Issues	**05**
	Total	**42**

Books Recommended:

Reference Books:
1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.

2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.

3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd Edition), Singapore, Pearson Education

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Program: B.Tech in Computer Science and Engineering (Data Science)	Final Year. B.Tech	Semester: VII
Course: **Public Systems and Policies (DJ19ILO7020)**		

Pre-requisites:
1. Basic Knowledge of Social science and Current affairs.

Objectives:
1. To analyze the transformations in public systems with emphasis on current initiatives and emerging challenges in the field.
2. To understand public systems in a fast-changing environment in the global context.
3. To provide an in-depth understanding of the ills prevailing in the society and aids to identify the solutions for them.
4. To explain public policy and its operations with special focus on policy relating to Government finance.
5. To analyze and evaluate the impact of the public policy on firms and economy at large.

Outcomes: On completion of the course, the learner will be able to:
1. Understand the importance of public systems in a fast-changing environment in the global context.
2. Analyze the transformations in public systems with emphasis on current initiatives and emerging challenges in the field.
3. Explain public policy and its operations with special focus on policy relating to Government finance.
4. Make policies and know about the happenings in the world, in the nation and those in their locality.
5. Analyze and evaluate the impact of the public policy on firms and economy at large and work under various fields as policymakers.

Public Systems and Policies (DJ19ILO7020)		
Unit	**Description**	**Duration**
1	**Introduction and Overview of Public Systems:** Ideology of Public Systems; Mechanistic and Organic view of Society and Individuals, The Legal Framework; Federal Government; State and Local Governments, Government growth; The size of Government.	**10**
2	**Public Sector in the Economics Accounts:** Public Sector in the circular flow; Public Sector in the National Income Accounts.	**06**
3	**Public Choice and Fiscal Politics:** Direct Democracy; Representative Democracy; The Allocation Function; The Distribution Function; The Stabilization Function; Coordination of Budget Functions; The Leviathan Hypothesis.	**08**
4	**Introduction and Overview of Public Policy:** Markets and Government; Social goods and Market failure, Public expenditure and its evaluation; Cost Benefit Analysis, Public policy	**12**

	and Externalities, Taxation Policy and its impact, Income distribution, redistribution and social security issues Fiscal & Budgetary Policy, Fiscal Federalism in India.	
5	**Case Studies in Expenditure Policy: Public Services** A) National Defense B) Highways C) Outdoor Recreation D) Education	**06**
		Total	**42**

Books Recommended:

Reference Books:

1. Introduction to Public Policy by Charles Wheelan, W.W. Norton & Company.
2. Understanding Public Policy by Thomas R. Dye, Prentice Hall.
3. Public Policy-Making: An Introduction by Anderson J.E., Boston, Houghton.
4. Public Administration by Avasthi & Maheshwari, Lakshminarayan Agarwal, Agra.
5. New Horizons of Public Administration by Bhattacharya, Mohit, Jawahar Publishers, New Delhi.
6. Public Administration and Public Affairs by Henry, Nicholas, Prentice Hall of India, New Delhi.
7. Public Finance 10th Edition by Harvey S Rosen and Ted Gayer, McGraw-Hill Education, 2013.
8. Public Finance in Theory and Practice by Musgrave and Musgrave.

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Program: B.Tech in Computer Science and Engineering (Data Science)	Final Year. B.Tech	Semester: VII
Course: Project Stage - I (DJ19DSP704)		

Course Objectives:

To introduce the students to professional engineering practice by providing them with an opportunity to work on an open-ended engineering problem. Typically, the students would apply knowledge from different areas or courses, which they have studied in their curriculum using methods, tools, and techniques, which they learned to a real-world scenario. Students would have to apply not only their engineering knowledge and proficiencies (hard skills), but also to demonstrate their competence in generic, professional skills (soft skills). It also emphasizes the importance of life-long learning as a fundamental attribute of graduate engineers.

Course Outcome:

Learner will be able to:

1. Discover potential research areas in the field of IT.
2. Survey several available literatures in the related field of study.
3. Compare the several existing solutions for research challenges.
4. Design the solution for the research plan.
5. Summarize the findings of the study conducted.
6. Work effectively as a member of the team.

Guidelines:

1. The department must allocate 1 day in the VII semester every week.
2. The project work is to be conducted by a group of 3-4 students.
3. Each group shall identify a potential research area/problem domain, on which the study is to be conducted and submit three proposals to the department.
4. Department will evaluate all the proposals and select the best proposal from each group. Every group will be associated with a project mentor/guide. The group should meet with the project mentor/guide periodically and record of the meetings and work discussed must be documented.
5. Students will do a rigorous literature survey of the problem domain by reading and understanding at least 10-12 research papers from current superior quality national/international journals/conferences. (Papers selected must be indexed by Scopus/IEEE/Springer/ACM etc.). The list of papers surveyed must be clearly documented and research gaps should be identified.
6. Students will design and implement (30-40%) the system in Semester VII.
7. Students will have to regularly submit their project completion tasks given by the department. Each task will be having weightage in the term work.
8. The project assessment for term work will be done based on regular submission of project tasks and presentation at the department level. The Head of the department of respective Program will give the presentation to the panel members, which consist of at least three (3) members as internal examiners (including the project guide/mentor) appointed.
9. A report is to be prepared summarizing the findings of the literature survey. A comparative evaluation of the different techniques surveyed is also to be done.

10. The term work calculation will be based on plan of data collection (10m), analysis of literature survey (15m), proposed design (15m), documentation and presentation (10m).