Shirpur Education Society's

R. C. Patel Institute of Technology, Shirpur

(An Autonomous Institute)

Course Structure and Syllabus

Final Year B. Tech

Computer Science and Engineering (Data Science)

With effect from Year 2024-25

Shahada Road, Near Nimzari Naka, Shirpur, Maharashtra 425405
Ph: 02563 259 802, Web: www.rcpit.ac.in

R. C. PATEL
INSTITUTE OF TECHNOLOGY
An Autonomous Institute

R. C. Patel Institute of Technology, Shirpur

Institute Vision

To become a leading Institute in Technical education fostering innovation, research, ethical values, and sustainable development for the betterment of society.

Institute Mission

To impart high quality Technical Education through:

M1: Innovative and Interactive learning process and high quality, globally recognized instructional programs.

M2: Fostering a collaborative scientific temper among students with ethical responsibility towards the society.

M3: Preparing students from diverse backgrounds to have aptitude for employment, entrepreneurship and research with a spirit of professionalism.

M4: To contribute to nation's sustainable development.

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Department Vision

To provide cutting-edge Computer Engineering education in Data Science while instilling socio-moral values.

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M1: To deliver state-of-the-art, ICT-enabled teaching and learning to achieve excellence in Data Science education.

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Program Specific Outcomes (PSOs) of the Department

PSO1: Apply programming concepts, algorithms, and data structures to develop data-driven software and web solutions.

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Final Year B. Tech Computer Science and Engineering (Data Science) Semester-VII (w.e.f. 2024-25)

Sr	Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme					Total	Credit	
							Continuous Assessment (CA)							
							TA	Term Test 1 (TT1)	Term Test 2 (TT2)	Average of (TT1 & TT2)	ESE			
				L	T	P	[A]			[B]	[C]	[A+B+C]		
1	PC	PCCS7010T	Machine Learning-IV	3			25	10	10	10	65	100	3	4
	PC	PCCS7010L	Machine Learning-IV Laboratory			2	25				25	50	1	
2	PC	PCCS7020T	Image Processing and Computer Vision-II	3			25	10	10	10	65	100	3	4
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4@	PE	PECS7041T	Parallel Computing	3			25	10	10	10	65	100	3	4
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		PECS7042L	Advanced Computational Linguistics Laboratory			2	25					25	1	
		PECS7043T	IoT Network Enterprise	3			25	10	10	10	65	100	3	
		PECS7043L	IoT Network Enterprise Laboratory			2	25					25	1	
		PECS7044T	Adversarial Machine Learning	3			25	10	10	10	65	100	3	
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		OECS7052T	Management Information System	3			25	10	10	10	65	100	3	
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		OECS7056T	Energy Audit and Management	3			25	10	10	10	65	100	3	
		OECS7057T	Disaster Management and Mitigation Measures	3			25	10	10	10	65	100	3	
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		OECS7059T	Research Methodology	3			25	10	10	10	65	100	3	
		OECS70510T	Public Systems and Policies	3			25	10	10	10	65	100	3	
6	PJ	PJCS7060L	Project Stage-II			8	25				25	50	4	4
			Total	12		16	250			40	310	600	20	

@Any 1 Professional Elective Course
#Any 1 Open Elective Course

Prepared by:
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Checked by:
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Semester - VII

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VII
Machine Learning-IV (PCCS7010T)		
Machine Learning-IV Laboratory (PCCS7010L)		

Prerequisite: Basic Machine Learning and Database Management System

Course Objective(s): To teach advance concepts of data management and data analysis for Big Data.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Evaluate the need of MapReduce framework.	L5	Evaluate
CO2	Apply appropriate method to handle big data.	L3	Apply
CO3	Apply suitable analysis method to draw conclusions from given big data.	L3	Apply

Machine Learning-IV (PCCS7010T)
Course Contents

Unit-I 04 Hrs.

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.

Unit-II 08 Hrs.

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.

Unit-III 08 Hrs.

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.

Unit-IV 07 Hrs.

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.

Unit-V 07 Hrs.

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.

Unit-VI 08 Hrs.

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.

Machine Learning-IV Laboratory (PCCS7010L)

List of Laboratory Experiments

Suggested Experiments:(At least 08 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.

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

Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

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 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: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VII
Image Processing and Computer Vision-II (PCCS7020T)		
Image Processing and Computer Vision-II Laboratory (PCCS7020L)		

Prerequisite: Mathematics for Intelligent System, Machine Learning-I and II and IPCV-I

Course Objective(s): 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.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Describe various data capturing methods.	L2	Understand
CO2	Apply appropriate object detection and object segmentation methods.	L3	Apply
CO3	Apply suitable method to analyze complex vision data.	L3	Apply
CO4	Develop suitable vision model for prediction.	L6	Create

Image Processing and Computer Vision-II (PCCS7020T) Course Contents

Unit-I 06 Hrs.

Camera Geometry Model: 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.

Unit-II 08 Hrs.

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.

Unit-III 06 Hrs.

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.

Unit-IV 07 Hrs.

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 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.

Unit-V 08 H

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)

Unit-VI 07 Hrs.

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.

Image Processing and Computer Vision-II Laboratory (PCCS7020L)

List of Laboratory Experiments

Suggested Experiments:(At least 06 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

At least one experiment on each: CNN, YOLO, GAN, Transfer Learning, U-Net should be im
mented. Any other experiment based on syllabus may be included which would help the learn

understand topic/concept.

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", 5^{th} 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. Aapo Hyvarinen, Jarmo Hurri and Patrick Hoyer, "Natural Image Statistics", Springer Verlag, 2009.
6. Simon Foucart and Holger Rauhut, "A Mathematical Introduction to Compressive Sensing", Birkhauser, 2013.
7. Hastie, Tibshirani and Wainwright,"Statistical Learning with Sparsity: The Lasso and Generalizations",CRC press, 2015.
8. R. Hartley and A. Zisserman, "Multiple View Geometry in Computer Vision", 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: Computer 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/

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VII
Applied Data Science Laboratory (PCCS7030L)		

Prerequisite: Machine Learning and Data Engineering

Course Objective(s): To bridge the gaps between industry and academia. Give the exposure of production system and applied data science.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Evaluate production systems available in the industry.	L5	Evaluate
CO2	Analyze various problems occurred in a data science production system.	L4	Analyze

Applied Data Science Laboratory (PCCS7030L) Course Contents

1. Converting Business problem into Data Science Problem: 02 Hrs
   (a) Bridging the Qualitative-to-Quantitative Gap in Data Science
   (b) Right Data Available with the Right Level of Granularity
   (c) Repeatability and Reproducibility: Consistency in Labelled Data for Accurate AI Systems
2. Agile Methodology: 04 Hrs
   (a) Work Breakdown structure for Agile Models
   (b) Scrum/XP modelling of Data Science Projects
   (c) Agile Tools for Project Management
3. Data Preparation Best Practice: 02 Hrs
   (a) Gathering suitable data for Data Science problem
   (b) Determine all Key Performance Indicators (KPIs)
   (c) Business stakeholders POC Dashboard
4. Data Modelling: 04 Hrs
   (a) Selection of appropriate tool
   (b) Data Modelling with Incremental Data
   (c) Data Modelling with Noisy Data.
   (d) Data Modelling with different data formats
5. Model Building Best Practice: 02 Hrs
   (a) One hot encoding
   (b) Selecting right metrics to evaluate the model
   (c) Identify and minimize Data Leakage
6. Modelling and Optimisation Trade-off: 03 Hrs
   (a) Need of Optimisation
   (b) Different methods of Optimization
   (c) Development
   (d) Rest APIs

7. Data Science Project Architecture: 03 Hrs

   (a) Functions of MLOps/DevOps

   (b) Difference between MLOps and DevOps

   (c) Collaboration, Scalability and Reusability

8. Project Deployment: 05 Hrs

   (a) Flask

   (b) Docker

   (c) Kubernetes

9. A/B Testing: 03 Hrs

   (a) Formulate Hypothesis

   (b) Create Test Group

   (c) Compare Results

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

Text Books:

1. "Data Science for Business Professionals",Probyto Data Science and Consulting Pvt. Ltd, 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.

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VII
Parallel Computing (PECS7041T)		
Parallel Computing Laboratory (PECS7041L)		

Prerequisite: System Fundamentals

Course Objective(s): To familiarize students with the fundamental concepts, techniques and tools of parallel computing.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Describe different structures of Parallel Computers.	L2	Understand
CO2	Apply parallel algorithms in problem solving.	L3	Apply

Parallel Computing (PECS7041T)
Course Contents

Unit-I 08 Hrs.

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.

Unit-II 06 Hrs.

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.

Unit-III 13 Hrs.

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.

Unit-IV 09 Hrs.

Parallel Programming: Parallel programming models, point to point communication, synchronous and asynchronous communication, shared memory programming, message passing programming, MPI, PVM, Threads.

Unit-V 06 Hrs.

Applications of Parallel Programming: Issues and challenges, scope of parallel computing, applications in data mining, computer security and cryptography, medicine and human organ modelling.

Parallel Computing Laboratory (PECS7041L)

List of Laboratory Experiments

Suggested Experiments:(At least 08 experiments)

1. To implement the parallel construct in OpenMP that creates a parallel region in a C++ c
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.

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

Text Books:

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

Reference Books:

1. Fayez Gebali, "Algorithms and Parallel Computing", Wiley Series, 1^{st} 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

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VII
Advanced Computational Linguistics (PECS7042T)		
Advanced Computational Linguistics Laboratory (PECS7042L)		

Prerequisite: Machine Learning-I and II, Computational Linguistics

Course Objective(s): To teach machine learning and deep Learning techniques to build Computational models for real world applications.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply classification techniques on linguistic data.	L3	Apply
CO2	Apply machine learning and deep learning techniques to build language model.	L3	Apply
CO3	Develop applications based on natural language processing.	L6	Create

Advanced Computational Linguistics (PECS7042T) Course Contents

Unit-I 07 Hrs.

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.

Unit-II 09 Hrs.

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.

Unit-III 10 Hrs.

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.

Unit-IV 09 Hrs.

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.

Unit-V 07 Hrs.

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 I[illegible] ing, Knowledge-based Question Answering, Using Language Models to do QA, Classic QA Mo[illegible]

Evaluation of Factoid Answers.

Advanced Computational Linguistics Laboratory (PECS7042L)

List of Laboratory Experiments

Suggested Experiments:(At least 08 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

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

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 Tr formers", 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

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VII
IoT Network Enterprise (PECS7043T)		
IoT Network Enterprise Laboratory (PECS7043L)		

Prerequisite: Analog and Digital Communication, Embedded Systems and RTOS.

Course Objective(s):

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.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Describe application & link layer services for wired and wireless applications.	L2	Understand
CO2	Design & optimize – sensors, power modules and actuation for constrained environment applications.	L6	Create
CO3	Comprehend and evaluate the mechanism needed for network security of application environment.	L5	Evaluate
CO4	Demonstrate the use of SaaS, PaaS and IaaS services.	L3	Apply

IoT Network Enterprise (PECS7043T)
Course Contents

Unit-I 14 Hrs.

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.

Unit-II 06 Hrs.

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.

Unit-III 08 Hrs.

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.

Unit-IV 10 Hrs.

Cybersecurity: Network Security- Packet Sniffing, ARP and IP Spoofing, Denial of Service attacks, Firewalls and 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.

Unit-V 04 Hrs.

Cloud Services: Virtualization-Taxonomy & Implementation of levels of Virtualization, Cloud Computing Architecture-Exploring AWS components: EC2, and S3 services.

IoT Network Enterprise Laboratory (PECS7043L)

List of Laboratory Experiments

Suggested Experiments:(At least 08 experiments)

1. Device Functionalities using Cisco Packet Tracer - Implementing Hubs, Switches & Route
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.

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

Text Books:

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

Reference Books:

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

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VII
Adversarial Machine Learning (PECS7044T)		
Adversarial Machine Learning Laboratory (PECS7044L)		

Prerequisite: Mathematics for Intelligent System, Machine Learning-I and Information Security

Course Objective(s): 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.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Outline the different categories of adversarial attacks and defenses against conventional machine learning models and deep learning models.	L4	Analyze
CO2	Identify the unique characteristics of adversarial machine learning attacks in the cybersecurity domain.	L3	Apply
CO3	Explain the basics of adversarial privacy attacks and privacy-preserving defense methods.	L2	Understand

Adversarial Machine Learning (PECS7044T)
Course Contents

Unit-I 06 Hrs.

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.

Unit-II 04 Hrs.

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.

Unit-III 13 Hrs.

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.

Unit-IV 13 Hrs.

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.

Unit-V 06 Hrs.

Adversarial Machine Learning Challenges:

Discussion and Open Problems, Unexplored Components of the Adversarial Game, Development of Defensive Technologies

Adversarial Machine Learning Laboratory (PECS7044L)

List of Laboratory Experiments

Suggested Experiments:(At least 08 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

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

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 ing your machines intelligent using the Python ecosystem", Packt Publishing, 1st Edition, 2

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)

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VII
Product Life Cycle Management (OECS7051T)		

Prerequisite: Knowledge of basic concepts of Management

Course Objective(s):

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.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Describe the phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.	L2	Understand
CO2	Illustrate various approaches and techniques for designing and developing products.	L3	Apply
CO3	Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.	L3	Apply
CO4	Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant.	L3	Apply

Product Life Cycle Management (OECS7051T)
Course Contents

Unit-I 10 Hrs.

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

Unit-II 08 Hrs.

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

Unit-III 08 Hrs.

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

Unit-IV 08 Hrs.

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.

Unit-V 08 H

Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life C

Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis.

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.

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VII
Management Information System (OECS7052T)		

Prerequisite: Knowledge of basic concepts of Management

Course Objective(s):

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.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain how information systems transform business.	L2	Understand
CO2	Use information systems concepts to assess their effects on organizational operations.	L3	Apply
CO3	Describe IT infrastructure and its components and its current trends.	L2	Understand
CO4	Explain principal tools and technologies for accessing information from databases to improve business performance and decision making.	L2	Understand
CO5	Use enterprise-wide knowledge management systems to show their benefits for business operations.	L3	Apply

Management Information System (OECS7052T) Course Contents

Unit-I 05 Hrs.

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.

Unit-II 08 Hrs.

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

Unit-III 08 Hrs.

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

Unit-IV 06 Hrs.

Security and Ethical Challenges: Security, Ethical, and Societal Challenges of IT Security Management of Information Technology.

Unit-V 07 Hrs.

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.

Unit-VI 08 Hrs.

Information System within Organization: Acquiring Information Systems and Applicat

Various System development life cycle models.

Enterprise and Global Management of Information Technology: Managing Information Technology, Managing Global IT.

Reference Books:

1. James A O'Brien, George M., Ramesh Behl,"Management Information Systems", 11^{th} Edition, Tata McGraw Hill, 2019.

2. Kelly Rainer, Brad Prince,"Management Information Systems", 2^{nd} Edition, Wiley, 2013.

3. K.C. Laudon and J.P. Laudon,"Management Information Systems: Managing the Digital Firm", 10^{th} Edition, Prentice Hall, 2007.

4. D. Boddy, A. Boonstra,"Managing Information Systems: Strategy and Organization", Prentice Hall, 2008. Prepared

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VII
Operations Research (OECS7053T)		

Prerequisite: Basic Knowledge of Algebra, Probability and Statistics

Course Objective(s):

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.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze a real-world problem by formulating it as a Linear Programming Problem and interpreting the solution obtained using the Simplex method or other algorithms.	L4	Analyze
CO2	Determine real-world problems as Transportation Problem and Assignment Problem and solve the decision problem by choosing appropriate algorithm.	L3	Apply
CO3	Determine the decision situations which vary with time and analyse them using principle of dynamic programming to real life situations.	L3	Apply
CO4	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.	L2	Understand
CO5	Explain the concept of decision making in situation of competition and recommend strategies in case of two-person zero sum games.	L2	Understand
CO6	Explain the concept of simulation and replacement policy, apply Monte Carlo Simulation technique to systems such as inventory and queuing, and determine optimal replacement age.	L2	Understand

Operations Research (OECS7053T)
Course Contents

Unit-I 10 Hrs.

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.

Unit-II 08 Hrs.

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.

Unit-III 06 Hrs.

Dynamic Programming: Bellman's Principle of optimality - Applications of dynamic programming- Employment smoothening problem, capital budgeting problem, shortest path problem, cargo loading problem

Unit-IV 10 Hrs.

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.

Unit-V 08 Hrs.

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 counted and counted, Replacement of items that fail suddenly – individual and group replacem

policy.

Text Books:

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

Reference Books:

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

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VII
Cyber Security and Laws (OECS7054T)		

Prerequisite: Knowledge of basic concepts of security

Course Objective(s):

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.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the different types of cybercrime and security issues in E-Business.	L2	Understand
CO2	Analyze different types of cyber threats and techniques for security management.	L4	Analyze
CO3	Analyze the legal requirements and standards for cyber security in various countries to regulate cyberspace.	L4	Analyze
CO4	Explain the Information Technology Act and the legal framework of right to privacy, data security, and data protection.	L2	Understand

Cyber Security and Laws (OECS7054T)
Course Contents

Unit-I 12 Hrs.

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

Unit-II 08 Hrs.

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

Unit-III 06 Hrs.

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-Payment Threats & Protections, Security for E-Commerce.

Unit-IV 08 Hrs.

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 Aspect in Cyber Law

Unit-V 08 H

Security Industries Standard Compliances:

IT Security v/s IT Compliance, Cyber Security Standards, critical security controls for cyber security, GRC (Governance, Risk Management, and Compliance), 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 Security Controls)

Reference Books:

1. Nina Godbole, Sunit Belapure, "Cyber Security", Wiley India, New Delhi.
2. Suresh T. Vishwanathan, "The Indian Cyber Law",Bharat Law House New Delhi.
3. "The Information Technology Act", Bare Act- Professional Book Publishers, New Delhi, 2000.
4. Anup K. Ghosh, "E-Commerce Security and Privacy", Springer Science and Business Media, 2012.
5. Izzat Alsmadi, "The NICE Cyber Security Framework Cyber Security Intelligence and Analytics", Springer.
6. Advocate Prashant Mali,"Cyber Law & Cyber Crimes", 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

Web Links:

1. The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
2. A Compliance Primer for IT professional: https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer- professionals-33538

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VII
Personal Finance Management (OECS7055T)		

Prerequisite: Basic Knowledge of Algebra, Probability and Statistics

Course Objective(s):

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.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Use a framework for financial planning to understand the overall role finances play in his/her personal life.	L3	Apply
CO2	Calculate income from salaries, house property, business/profession, capital gains and income from other sources.	L3	Apply
CO3	Calculate the amount of CGST, SGST and IGST payable after considering the eligible input tax credit.	L3	Apply
CO4	Describe how Microfinance can help in financial inclusion.	L2	Understand

Personal Finance Management (OECS7055T)
Course Contents

Unit-I 07 Hrs.

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.

Unit-II 07 Hrs.

Personal Financial Management:

Loans: Home, Car, Education, Personal, Loan against property and Jewel loan. Insurance: Types of Insurance – ULIP and Term; Health and Disability Income Insurance, Life Insurance.

Investment: Investing Basics and Evaluating Bonds, Investing in Stocks and Investing in Mutual Funds, Planning for the Future.

Unit-III 08 Hrs.

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.

Unit-IV 10 Hrs.

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; Major Defects 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

Unit-V 10 Hrs.

Introduction to Micro – finance: Micro-Finance: Definitions, Scope & Assumptions, Types of Microfinance, Customers of 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.

Reference Books:

1. Asha Singh, M.S. Gupta, "Banking and Financial Sector Reforms in India" , Serials Publication.
2. M.S. Gupta & J.B. Singh,"Indian Banking Sector: Essays and Issues",1st Edition, Serials Publication.
3. K.M. Bhattacharya O.P. Agarwal,"Basics Of Banking & Finance", Himalaya Publishing House.
4. S. Subba Reddy , P. Raghu Ram, "Agricultural Finance And Management".
5. Dr.Vasant Desai, "The Indian Financial System And Development", 4th Edition, Himalaya Publishing House.
6. Sanjay Kumar Satapathy, "Income Tax Management Simple Way of Tax Management, Tax Planning and Tax Saving".
7. Dr. R. K. Jain, "Direct Tax System Income Tax", SBPD Publications.
8. S K Mishra,"Simplified Approach to GST Goods and Services Tax", Educreation Publishing.
9. Todd A Watkins, "Introduction To Microfinance", World Scientific Publishing Company.

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VII
Energy Audit and Management (OECS7056T)		

Prerequisite: Knowledge of basic concepts of Management

Course Objective(s):

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.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Identify and describe the present state of energy security and its importance.	L2	Understand
CO2	Identify and describe the basic principles and methodologies adopted in the energy audit of a utility.	L2	Understand
CO3	Describe the energy performance evaluation of some common electrical installations and identify energy-saving opportunities.	L2	Understand
CO4	Describe the energy performance evaluation of some common thermal installations and identify energy-saving opportunities.	L2	Understand
CO5	Analyze the data collected during performance evaluation and recommend energy-saving measures.	L4	Analyze

Energy Audit and Management (OECS7056T)
Course Contents

Unit-I 05 Hrs.

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.

Unit-II 10 Hrs.

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).

Unit-III 10 Hrs.

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 water pumps, compressor, fan and blower. industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives

Unit-IV 10 Hrs.

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.

Unit-V 07 Hrs.

Energy conservation in Buildings: Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources, Energy sou
and energy management in electric vehicles.

Reference Books:

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

Web Links:

1. www.energymanagertraining.com
2. www.bee-india.nic.in

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VII
Disaster Management and Mitigation Measures (OECS7057T)		

Prerequisite: Nil

Course Objective(s):

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.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Describe natural as well as man-made disasters, their extent, and possible effects on the economy.	L2	Understand
CO2	Describe the institutional framework and organizational structure in India for disaster management and explain government policies, acts, and various emergency laws.	L2	Understand
CO3	Describe the simple do's and don'ts during extreme events and explain the skills required to respond accordingly.	L2	Understand
CO4	Explain the importance of disaster prevention and various mitigation measures with exposure to disaster hotspots across the globe.	L2	Understand

Disaster Management and Mitigation Measures (OECS7057T) Course Contents

Unit-I 10 Hrs.

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.

Unit-II 08 Hrs.

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.

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.

Unit-III 08 Hrs.

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 National disaster 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, Jobs carried out by armed forces, Financial Relief During disaster (State, National and International Disaster Assistance)

Unit-IV 08 Hrs.

Disaster risk reduction and Mitigation Measures: Need of disaster prevention and mitigation, mitigation guiding principles, challenging areas, structural and non-structural measures for dis 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.

Unit-V 08 Hrs.

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)

Reference Books:

1. Harsh K.Gupta,"Disaster Management", Universities Press Publications (2003).
2. O.S.Dagur, "Disaster Management: An Appraisal of Institutional Mechanisms in India", published by Centre for land warfare studies, New Delhi, 2011.
3. Damon Copolla,"Introduction to International Disaster Management", Butterworth Heinemann Elsevier Publications (2015).
4. Jack Pinkowski, "Disaster Management Handbook", CRC Press, Taylor and Francis group (2008).
5. Rajdeep Dasgupta, "Disaster management & rehabilitation", Mittal Publications, New Delhi (2007).
6. R B Singh,"Natural Hazards and Disaster Management, Vulnerability and Mitigation", Rawat Publications (2006).
7. C.P.Lo Albert, K.W. Yonng, "Concepts and Techniques of GIS", Prentice Hall (India) Publications (2006).
8. Claudia G. Flores Gonzales, "Risk management of natural disasters", KIT Scientific Publishing (2010).
9. W. Nick Carter, "Disaster Management – a disaster manger's handbook", Asian Development Bank (2008).
10. R. K. Srivastava, "Disaster Management in India", Ministry of Home Affairs, GoI, New Delhi (2011)
11. Wil Mara,"The Chernobyl Disaster: Legacy and Impact on the Future of Nuclear Ener Marshall Cavendish Corporation, New York, 2011.

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

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

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VII
Science of Well-being (OECS7058T)		

Prerequisite: Nil

Course Objective(s):

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.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Describe concepts of holistic health and well-being, differentiate between its true meaning and misconceptions, and explain the benefits of well-being.	L2	Understand
CO2	Describe the meaning of happiness, practice gratitude and self-compassion, and analyze incidents from one's own life.	L2	Understand
CO3	Explain the causes and effects of stress, identify reasons for stress in one's own surroundings and self.	L2	Understand
CO4	Describe the importance of physical health and fitness, assess one's lifestyle, and justify its limitations or effectiveness.	L2	Understand
CO5	Analyze one's own coping mechanisms, assess their effectiveness, develop and strategize for betterment, and execute them.	L4	Analyze

Science of Well-being (OECS7058T)
Course Contents

Unit-I 06 Hrs.

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.

Unit-II 08 Hrs.

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.

Unit-III 10 Hrs.

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 stressors and their health consequences, relation between stress and illness from different perspectives association between stress related physiological mechanisms and different illnesses.

Unit-IV 10 Hrs.

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.

Unit-V 08 Hrs.

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 Chr 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.

Text Books:

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

Reference Books:

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

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VII
Research Methodology (OECS7059T)		

Prerequisite: Basic Knowledge of Probability and Statistics.

Course Objective(s):

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.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply preliminary research design concepts for projects in their subject matter areas.	L3	Apply
CO2	Analyze and report research data using appropriate statistical and analytical techniques.	L4	Analyze
CO3	Explain complex data or situations clearly.	L2	Understand
CO4	Analyze the research findings.	L4	Analyze
CO5	Summarize a structured research report based on research findings.	L2	Understand

Research Methodology (OECS7059T)
Course Contents

Unit-I 07 Hrs.

Basic Research Concepts: Meaning of research, Objectives of research, Types of research, Significance of research Research process

Unit-II 10 Hrs.

Research Methodology: Identification of research problem, Literature review, Formulation of hypothesis, Formulation of Research design.

Unit-III 10 Hrs.

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.

Unit-IV 10 Hrs.

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

Unit-V 05 Hrs.

Interpretation and Report Writing: Interpretation and drawing conclusions on the research, Preparation of the report, Ethical Issues

Reference Books:

1. Dawson, Catherine, "Practical Research Methods", New Delhi, UBS Publishers Distributors, 2002,.
2. Kothari, C.R.,"Research Methodology-Methods and Techniques", New Delhi, Wiley Eastern Limited, 1985.
3. Kumar, Ranjit, 2005, "Research Methodology-A Step-by-Step Guide for Beginners", 2nd Edition, Singapore, Pearson Education.

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VII
Public Systems and Policies (OECS70510T)		

Prerequisite: Basic Knowledge of Social science and Current affairs

Course Objective(s):

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.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the importance of public systems in a fast-changing environment in the global context.	L2	Understand
CO2	Analyze the transformations in public systems with emphasis on current initiatives and emerging challenges in the field.	L4	Analyze
CO3	Explain public policy and its operations with special focus on policy relating to Government finance.	L2	Understand
CO4	Analyze the impact of public policy on firms and the economy at large and work under various fields as policymakers.	L4	Analyze
CO5	Apply analytical skills through Expenditure Policy in public services case studies.	L3	Apply

Public Systems and Policies (OECS70510T)
Course Contents

Unit-I 10 Hrs.

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.

Unit-II 06 Hrs.

Public Sector in the Economics Accounts: Public Sector in the circular flow; Public Sector in the National Income Accounts.

Unit-III 08 Hrs.

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.

Unit-IV 12 Hrs.

Introduction and Overview of Public Policy: Markets and Government; Social goods and Market failure, Public expenditure and its evaluation; Cost Benefit Analysis, Public policy and Externalities, Taxation Policy and its impact, Income distribution, redistribution and social security issues Fiscal & Budgetary Policy, Fiscal Federalism in India.

Unit-V 06 Hrs.

Case Studies in Expenditure Policy: Public Services

A) National Defense B) Highways C) Outdoor Recreation D) Education

Reference Books:

1. Charles Wheelan, "Introduction to Public Policy", W.W. Norton & Company.
2. Thomas R. Dye, "Understanding Public Policy", Prentice Hall.
3. Anderson J.E.,"Public Policy-Making: An Introduction", Boston, Houghton.
4. Avasthi & Maheshwari, "Public Administration", Lakshminarayan Agarwal, Agra.
5. Bhattacharya, Mohit, "New Horizons of Public Administration", Jawahar Publishers, New Delhi.
6. Henry, Nicholas,"Public Administration and Public Affairs", Prentice Hall of India, New D

7. Harvey S Rosen and Ted Gayer, "Public Finance", 10^{th} Edition, McGraw-Hill Education, 2013.

8. Musgrave and Musgrave, "Public Finance in Theory and Practice".

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VII
Project Stage-II (PJCS7060L)		

Course Objectives:

1. To understand the basic concepts and principles in the development of solution.
2. To formulate solution of the problem statement.
3. To implement the solution as per the problem statement.
4. To develop team building, writing, logical reasoning and management skills.
5. To validate the proposed solution with different test cases.
6. To become independent person with ethical values and lifelong learning skills.

Course Outcomes:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze the problem statement and produce solution of the problem considering cultural, social, environmental and economic factors using appropriate tool and method.	L4	Analyse
CO2	Interpret project based learning that allows students to transfer existing ideas into new applications.	L2	Understand
CO3	Apply the ability to work in teams and manage to conduct the project development activity.	L3	Apply
CO4	Use different perspectives from relevant disciplines which help them to get internships, jobs, and admission for higher studies.	L3	Apply
CO5	Explain the project development in the form of technical writing, and interpret what constitutes plagiarism and the use of proper referencing styles.	L2	Understand

Syllabus:

Project-I work done in VI semester shall be continued as Project-II in semester VII.

Students should complete remaining implementation of ideas given in synopsis/Abstract of semester VI.

Students / group must plan their execution of project, so that project work should be completed before end of semester.

Project-II involves fabrication, design, experimentation, data analysis within realistic constraints such as economic, environmental, social, ethical, health and safety, manufacturability, and sustainability. The stage also includes testing, possible results and report writing.

Each project group is required to maintain log book for documenting various activities of Project-II and submit group project report at the end of Semester-VII in the form of Hard bound.

Domain knowledge (any beyond) needed from the various areas in the field of Computer Science & Engineering (Data Science) for the effective implementation of the project.

The above areas can be updated based on the technological innovations and development needed for specific project.

Guidelines:

The main purpose of this activity is to improve the students' technical skills, communication skills by integrating writing, presentation and teamwork opportunities.

Each group will be reviewed twice in a semester and marks will be allotted based on the various points mentioned in the evaluation scheme.

In the first review of this semester, each group is expected to complete 70% of project.

In the second review of this semester, each group is expected to complete 100% of project.

The students may use this opportunity to learn different computational techniques towards development of a product.

Interaction with alumni mentor will also be appreciated for the improvement of project.

Student is expected to:

- Maintain Log Book of weekly work done(Log Book Format will be as per Table 1).
- Report weekly to the project guide along with log book.

Table 1: Log Book Format

Sr	Week (Start Date:End Date)	Work Done	Sign of Guide	Sign of Coordinator
1				
2				

Assessment Criteria:

- At the end of the semester, after confirmation by the project guide, each project group will submit project completion report in prescribed format for assessment to the departmental committee (including project guide).
- Assessment of the project (at the end of the semester) will be done by the departmental committee (including project guide).
- The candidate must bring the Project Stage-I report and the final report completed in all respect while appearing for End Semester Examination.
- Oral examination should be conducted by Internal and External examiners. Students have to give presentation and demonstration based on their project.

Prescribed project report guidelines:

Every group should prepare hard bound report (preferrable LaTeX) of about minimum 40 pages on the work carried out by a batch of students in respect of the project work done during semester-VII. Project Report should include appropriate content for:

- Title
- Abstract
- Introduction
- Problem identification and project objectives
- Literature Survey
- Related Theory
- Project design and Implementation details
- Case study/Analysis/Design Methodology
- Project Outcomes
- Result and Conclusion
- Future scope
- References

Assessment criteria for the departmental committee for Continuous Assessment:

Guide will monitor weekly progress and marks allocation will be as per Table 2.

Assessment criteria for the departmental committee for End Semester Exam:

Departmental committee will evaluate project as per Table 3.

Table 2: Continuous Assessment Table

Sr	Exam Seat No	Name of Student	Student Attendance	Log Book Logbook Maintenance	Literature Review	Depth of Understanding	Report	Total
			5	5	5	5	5	25

Assessment criteria for the departmental committee (including project guide) for End Semester Exam:

Each group will be reviewed twice in a semester by faculty guide and faculty coordinator based on the following criteria:

- Project progress
- Documentation/Technical paper writing
- Key findings
- Validation of results
- Product Development

Each review consists of 25 marks. Average of the marks scored in both the two reviews will be considered for final grading. The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

Table 3: Evaluation Table

Sr	Exam Seat No	Name of Student	Project Selection	Design/ Methodology	Implementation/ Modelling/ Simulation	Result Verification	Presentation	Total
			5	5	5	5	5	25

Semester - VIII

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VIII
High Performance Computing (PECS8011T)		

Prerequisite: System Fundamentals

Course Objective(s):

This course in High-Performance Computing (HPC) for Data Science with an emphasis on GPU parallel computing introduces students to the fundamental concepts and practical skills necessary for harnessing the power of Graphics Processing Units (GPUs) in data-intensive computations. Throughout the course, students will explore GPU architecture, CUDA programming, memory optimization techniques, parallel programming patterns, and performance optimization strategies. They will also delve into advanced topics like GPU-accelerated libraries and the integration of GPUs with popular data science frameworks. By the end of this course, students will be equipped to leverage GPU parallel computing to significantly enhance the efficiency and performance of data science applications.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Describe architecture and capabilities of GPUs, and explain the relevance of GPUs in data science.	L2	Understand
CO2	Evaluate GPU-based applications and identify and address performance bottlenecks, make efficient use of GPU memory, and apply parallel programming patterns to solve data science problems.	L5	Evaluate
CO3	Apply GPU-accelerated techniques to perform data processing and machine learning tasks in order to improve the speed and efficiency of data-driven decision-making.	L3	Apply

High Performance Computing (PECS8011T)
Course Contents

Unit-I 05 Hrs.

Basics of Parallelization: Data Parallelism, Functional parallelism, Parallel Scalability, Factors that limit parallel execution, Scalability matrices, Refined Performance model, load imbalance.

Unit-II 06 Hrs.

Introduction to High-Performance Computing: Introduction to HPC and its significance in data science, Overview of different hardware architectures (CPU, GPU, FPGA), Understanding parallel computing concepts and terminology, Introduction to programming models (shared memory, distributed memory).

Unit-III 08 Hrs.

Introduction to GPUs and CUDA Programming: Introduction to GPUs and their architecture, Overview of CUDA programming model CUDA programming basics: memory management, thread hierarchy, kernel execution.

Unit-IV 08 Hrs.

GPU Memory Optimization Techniques: GPU memory hierarchy and its impact on performance, Memory coalescing and memory access patterns, Shared memory and thread synchronization techniques, Techniques for reducing memory transfers between CPU and GPU.

Unit-V 08 Hrs.

Performance Optimization on GPUs: Profiling and performance analysis tools for GPUs, Techniques for optimizing GPU performance (warp divergence, loop unrolling, vectorization), Memory bandwidth optimization techniques, Advanced GPU programming concepts (shared memory atomics, warp shuffling).

Unit-VI 07 Hrs.

Advanced Topics in GPU: Computing Introduction to GPU-accelerated libraries (cuBLAS, cuDNN, cuGraph), GPU computing frameworks (TensorFlow, PyTorch) and their integration with GPUs, Introduction to GPU clusters and distributed GPU computing, Case studies and real-world applications of GPU computing in data science

Text Books:

1. Georg Hager, Gerhard Wellein, "Introduction to High Performance computing for Scientist

Engineers", CRC press, 2019.

2. Duane Storti and Mete Yurtoglu, "CUDA for Engineers", Addison-Wesley, 1st Edition, 2016.

Reference Books:

1. David B. Kirk and Wen-mei W. Hwu, "Programming Massively Parallel Processors: A Hands on Approach", Morgan Kaufmann, 4th Edition, 2022.

2. Charles Severance and Kevin Dowd, "High Performance Computing", O Reilly, 2018.

3. Jason Sanders and Edward Kandrot, "CUDA by Example: An Introduction to General-Purpose GPU Programming", Addison-Wesley, 1st Edition, 2010.

4. Duane Storti and Mete Yurtoglu, "CUDA for Engineers: An Introduction to High-Performance Parallel Computing", Addison-Wesley, 1st Edition, 2015.

Web Links:

1. GPU Gems series(1-3)by NVIDIA Corporation:-
   https://developer.nvidia.com/gpugems/gpugems/contributors

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VIII
Advanced Networking Technology (PECS8012T)		

Prerequisite: IoT Enterprise Network, Wireless Communication & Digital Communication

Course Objective(s):

1. Comprehend & Design a complete Campus/wide network from Access layer to Security.
2. Evaluate Interior & Exterior Routing Algorithms & ensure failsafe design implementations.
3. Introduce concepts of VPN, MPLS & Software Defined Networks for Emerging Technologies.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Evaluate small–medium scale networks from access layer to backbone layer.	L5	Evaluate
CO2	Design for emerging areas such as IoT and IIoT.	L6	Create
CO3	Develop new technologies that are high speed, high security, high QoS networks.	L6	Create

Advanced Networking Technology (PECS8012T) Course Contents

Unit-I 05 Hrs.

Applying a Methodology to Network Design:

The Cisco Service Oriented Network Architecture, Network Design Methodology, Identifying Customer Requirements, Characterizing the Existing Network and Sites, Using the Top Down Approach to Network Design, The Design Implementation Process.

Unit-II 05 Hrs.

Designing Basic Campus and Data Center Networks:

Campus Design Considerations, Enterprise Campus Design, Enterprise Data Center Design Considerations.

Unit-III 07 Hrs.

IP Subnets & Network Design:

3-Tier Network Design – Access layer, Distribution layer & Backbone layer (User – Service Provider), IP Addressing using IPv4 and IPv6 with Classful & Classless Routing Protocols.

Design using VLANs – IEEE 802.1Q, ISL(Inter-Switch Link), VLAN Trunking Protocol: VTP Server-Client Mode, VTP Transparent Mode & VTP Pruning.

Unit-IV 09 Hrs.

IP Routing Design:

Distance Vector Routing (Bellman Ford Algorithm) Vs Link State Routing (Dijikstra's).

Interior Gateway Routing Protocols - RIP, OSPF & EIGRP & Exterior Routing Protocols- Border Gateway Protocol (BGP).

IP Routing using FLSM- Fixed Length Subnet Masking and VLSM Variable Length Subnet Masking, Designing Subnetting using VLSM and Manual Route Summarization Vs Auto-summarization.

Spanning Tree Protocol- STP & Rapid STP (IEEE 802.1d & IEEE 802.1w)

& STP Configuration with verification.

IP Access Control Lists – Standard and Extended ACL with Wildcard masks, Named IP ACL.

Unit-V 07 Hrs.

Virtual Private Networks & Scaling the IP address space:

VPN Fundamentals, IPsec VPNs- IPsec Encryption, IPsec Key Exchange, IPsec Authenticati
Message Integrity, IPsec Implementation Considerations, SSL VPNs.

CIDR - Private Addressing & Route Aggregation.

Network Address Translation (NAT) – Static NAT & Dynamic NAT & Port Address Translation.

Unit-VI 09 Hrs.

Multi-Protocol Label Switching (MPLS) & Software Defined Networking – SDN

MPLS Technology & its use, Label Distribution in MPLS, MPLS services- Traffic Engineering using QoS, Configuring MPLS.

SDN – Benefits & differences from Classical Networking, Models of SDN, SDN Architecture, QoS, Scalability & Security in SDN – Features & Issues.

Text Books:

1. Wendell Odom/ Lammle Todd, "CCNA ICND1-2: Official Exam Certification Guide", Sybex, 1st Edition, 2020.
2. Beherouz A Forouzan , "TCP /IP Protocol Suite", Tata McGraw Hill Education ,4th Edition, 2018.

Reference Books:

1. Darren L. Spohn, "Data Network Design" , McGraw Hill Education, 3rd Edition, 2002.
2. William Stallings, "Wireless Communications and Networks", Pearson, 2nd Edition, 2009.
3. Vijay Garg, "Wireless Communication and networking", Morgan Kaufmann Publishers, 1st Edition, 2008.
4. Carr and Snyder, "Data communication and network security", McGraw Hill ,1st Edition, 2006.

Web Links:

1. NPTEL Course: https://onlinecourses.nptel.ac.in/noc23_cs35/preview
2. Global Certification Course: https://aws.amazon.com/certification/certified-advanced-networking-specialty

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VIII
Introduction to Quantum Computing (PECS8013T)		

Prerequisite: System Fundamental, Machine Learning, Information Security

Course Objective(s):

1. To introduce the basics of Quantum Computing and Quantum state transformation and classical computation versions.
2. To understand advanced Quantum Computation Algorithms and basics of Quantum Machine Learning.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze Quantum Building Blocks.	L4	Analyze
CO2	Apply advanced quantum computation algorithms for a real-world problem statement.	L3	Apply

Introduction to Quantum Computing (PECS8013T) Course Contents

Unit-I 07 Hrs.

Complex Numbers, Vector Space, and Dirac Notation: Complex Numbers, Complex Conjugation, Vector Space, Basic set, Dirac Notation, Ket and Bra, Inner Product, Linearly Dependent and Independent Vectors, Dual Vector Space, Computational Basis, Outer Product, Spin and Qubit.

Unit-II 07 Hrs.

Quantum Computing vs. Classical Computing: History of quantum computation and quantum information, Quantum State, Bloch sphere, Dense coding, Physical quantum phenomena: Spin, Quantum superposition, Interference and Entanglement.

Logic Gates and Circuits: Boolean Algebra, Functional Completeness, Gates, Circuits, Universal Gates, Gates and Computation

Quantum Gates and Circuits: Qubits, The CNOT, Pauli, Hadamard, Toffoli Gates, Quantum Gate, Quantum Gates Acting on one Qubit, No Cloning Theorem, Quantum Computation, Multiple qubit gates, Qubit copying circuit, Example: Bell states, quantum teleportation.

Unit-III 06 Hrs.

Quantum Computing algorithms: Classical computations on a quantum computer, Quantum parallelism, Quantum key distribution, Superdense coding, quantum teleportation, applications of teleportation, probabilistic versus quantum algorithms, phase kick-back, Quantum phase estimation and quantum Fourier Transform, eigenvalue estimation, Shor's Factorization Algorithm, Grover's Search Algorithm, Quantum algorithms summarized.

Unit-IV 05 Hrs.

Quantum Cryptography algorithm: Cryptography using principles of quantum computing, No-cloning theorem, Quantum key distribution Algorithm, Quantum secret sharing Algorithm.

Unit-V 09 Hrs.

Quantum Machine Learning Basic (QML): Variational Quantum Circuits, Parameterized quantum circuits, Parameterized quantum circuit properties, Entangling capability, Parameterized quantum circuits for machine learning Data encoding Methods, Basis encoding, Amplitude encoding, Angle encoding, Arbitrary encoding, Supervised learning, Quantum variational classification, Quantum kernel estimation, Variational training, Quantum Support Vector Machine (QSVM).

Unit-VI 08 Hrs.

Quantum Deep Learning (QDL): Basics of Quantum Neural Networks, Finite difference gradients, Analytic gradients, Natural gradients, Simultaneous Perturbation Stochastic Approximation, Training in practice, exponentially vanishing gradients (barren plateaus), Quantum Convolutional Neural Network.

Text Books:

1. Parag K. Lala, "Quantum Computing", McGraw Hill, 1st Edition, 2020.
2. Chris Bernhardt, "Quantum Computing for Everyone", MIT Press, 1st Edition, 2020

Reference Books:

1. Jack D. Hidary, "Quantum Computing: An Applied Approach", Springer, 2nd Edition, 2021.
2. Johan Vos, "Quantum Computing in Action", Manning Publications, 1st Edition, 2022.

Web Links:

1. https://qiskit.org/learn
2. https://elearn.nptel.ac.in/shop/iit-workshops/completed/quantum-computing/

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VIII
Social Network Analysis (PECS8021T)		

Prerequisite: Probability and Statistics and Machine Learning

Course Objective(s):

The analysis of massive networks which provide many computational, algorithmic, modeling challenges and research on the structure and analysis of such large networks.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze a social network using various visualization tools.	L4	Analyze
CO2	Illustrate large-scale network data and mechanisms used for network growth models.	L3	Apply
CO3	Evaluate social network analysis and prediction using case studies.	L5	Evaluate
CO4	Apply appropriate anomaly detection and graph representation method on a network.	L3	Apply

Social Network Analysis (PECS8021T)
Course Contents

Unit-I 06 Hrs.

Society & Network: Introduction, Use of social networks, defining a network, types of network (link-centric, node and link centric, local view, temporal view, generalization, real-world network), levels of social network analysis, graph visualization tools (web-based and standalone), applications.

Network Measures: Network basics, node centrality, assortativity, transitivity and reciprocity, similarity, degeneracy.

Unit-II 08 Hrs.

Network Growth Models: Properties of real world networks, Random Network Model: Degree Distribution of Random Network, Binomial to Poisson Distribution, Evolution of a Random Network, Average Path Length, Clustering Coefficient, Random Network vs. Real-world Network, Ring Lattice Network Model, Watts-Strogatz Model: Network Formation, Preferential Attachment Model: Network Formation, Degree Dynamics, Limitations of BA Model.

Unit-III 06 Hrs.

Link Analysis: Application of link analysis, Signed networks: Balance Theory of Undirected Signed Networks, Status Theory of Signed Networks, Triad Balance vs Status, Strong and Weak Ties: Strength of a Tie, Triadic Closure, Dunbar Number, Local Bridges and Importance of Weak Ties, PageRank, Personalised PageRank, DivRank, SimRank, PathSim.

Unit-IV 09 Hrs.

Community Detection: Application of community detection, types of communities, community detection methods, Disjoint Community Detection: Node-centric community detection, modularity and community detection, Overlapping Community Detection: Clique Dynamics, Local Community Detection.

Link Prediction: Applications of link prediction, Evaluating Link Prediction methods, Heuristic models, Probabilistic models, Supervised Random Walk.

Unit-V 06 Hrs.

Cascade Behaviours & Network Effects: Preliminaries and Important Terminologies, Cascade Models, Probabilistic Cascades, Epidemic Models, Independent Cascade Models, Cascade Prediction.

Unit-VI 07 H

Anomaly Detection in Networks: Anomaly in Static Networks: Plain and attributed netw

relational learning, Anomaly in Dynamic Networks: Preliminaries, feature and decomposition-based approaches.

Graphical Representation Learning: Criterion of graph representation learning, pipeline, representation learning methods.

Text Books:

1. Tanmoy Chakraborty, "Social Network Analysis", 1st Edition, Wiley, 2021.
2. Stephen P Borgatti, Martin G. Everett, Jeffrey C. Johnson ,"Analyzing Social Networks", Sage Publications Ltd, 2nd Edition, 2018.

Reference Books:

1. Xiaoming Fu, Jar-Der Luo, Margarete Boos, "Social Network Analysis Interdisciplinary Approaches and Case Studies", 1st Edition, CRC Press, 2020.
2. Dr. Krishna Raj P.M., Mr. Ankith Mohan, Dr. Srinivasa K.G, "Practical Social Network Analysis with Python (Computer Communications and Networks)", 1st Edition, Springer, 2019.
3. John Scott, "Social Network Analysis", 4th Edition, SAGE Publications Ltd, 2017.
4. Song Yang, Franziska Barbara Keller, Lu Zheng, "Social Network Analysis: Methods and Examples", 1st Edition, SAGE Publications, 2016.

Web Links:

1. A course on Social Network Analysis: https://onlinecourses.nptel.ac.in/noc22_cs117/preview
2. A comprehensive guide to Social Network Analysis: https://towardsdatascience.com/how-to-get-started-with-social-network-analysis-6d527685d374
3. Social Network Analysis 101: Ultimate Guide Comprehensive Introduction for Beginners: https://visiblenetworklabs.com/guides/social-network-analysis-101/

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VIII
Data Ethics (PECS8022T)		

Prerequisite: Data Science Basics, Fundamentals of Computer Science

Course Objective(s):

To introduce and understand the fundamental concepts of Data Ethics and familiarize students with Algorithmic bias, Privacy, and Governance of data in an ethical environment.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Describe the basic concepts related to Data Ethics and data driven business model.	L2	Understand
CO2	Explain the concept of Bias and Privacy in relation to Data Ethics.	L2	Understand
CO3	Discuss various digital trust and data governance in different applications.	L2	Understand

Data Ethics (PECS8022T)
Course Contents

Unit-I 07 Hrs.

Introduction to Data Ethics: Overview and Importance of Data Ethics. The significance of data ethics in modern technology, its impact on individuals and society.

Historical Examples of Data Ethics Violations: A historical perspective on data ethics violations, such as data breaches and misuse of data. Consequences of ethical lapses and their implications for technology and society.

Overview of Ethical Theories: Exploration of ethical theories, including utilitarianism, deontology, virtue ethics, and their application in data ethics. Applying Ethical Frameworks to Data-Related Dilemmas Practical application of ethical frameworks to analyze and address data-related ethical dilemmas.

Case Study: Facial recognition technology by the New York Police Department (NYPD) in the wake of protests of police brutality and racial injustice in 2020.

Unit-II 07 Hrs.

Data-driven Business Model: Data as payment, good data, Data at risk, Data brokers in a grey area, a need for new business models, Needs of customers: general concern for digital surveillance, targeted ads and prices, demand for data control, act, consumers cookies and using VPM, false data on the rise, obfuscation, from lack of knowledge to resignation, pay for privacy, Best practices for data ethics, Emerging Technologies and Ethical Challenges, Examination of ethical challenges posed by emerging technologies like AI, IoT, and blockchain.

Case Study: COVID-19 Vaccine Distribution and Equity, ethical dilemmas in cutting-edge projects.

Unit-III 06 Hrs.

Bias & Analysis: Introduction and Importance of Algorithm Fairness, the reasons for unfairness, Analyzing and measuring unfairness, Sources of Bias, Dealing with Bias, Mitigating Bias , Further Considerations, addressing different types of bias, Examples, causes and detection strategies of algorithmic biases, Detecting and Addressing Bias in Data and Algorithms, Understanding the types of bias in data and algorithms (selection bias and algorithmic bias), Techniques and tools for identifying and mitigating bias in data-driven projects.

Case Studies: Aequitas - A Toolkit for Auditing Bias and Fairness in Machine Learning Models.

Unit-IV 09 Hrs.

Data Privacy: Data Privacy and Legal Frameworks, Data Privacy Laws and Regulations, GI
CCPA, and HIPAA, Understanding the key principles and requirements of privacy laws, Data

modification's, examples of companies complying with or violating data privacy regulations, Data Collection and Storage Ethics Considerations for ethical data collection methods, including informed consent, data minimization, and transparency, Exploring fairness in machine learning models and algorithmic transparency.

Data Storage and Secure Handling: Encryption, and data handling protocols, Strategies for ensuring data security and integrity, Cybersecurity and Data Breaches, Handling Data Breaches Responsibly, Ethical and legal obligations following a data breach, including incident response and notification procedures.

Case studies: Facebook's Data Privacy Controversies, Ethical data collection in various contexts.

Unit-V 07 Hrs.

Data Ethics and Trust: Introduction to digital trust, the snowden effect, the sharing economy, ethical data use, sharing and access, ethical considerations when sharing data with partners, stakeholders, and the public, Strategies for ensuring responsible data sharing and access Best Practices for Responsible Data Use, Strategies for integrating data ethics into professional practices, software development, system design, and decision-making processes.

Case studies: Real-world examples of organizations implementing responsible data use practices.

Unit-VI 06 Hrs.

Data Governance and Regulation: Introduction to Data Governance, Importance of Governance, Examples of Data Governance in action, The Business value of Data Governance, why data Governance is easier in the public cloud, Ingredients of Data Governance: Tools

Case studies: The Volkswagen (VW) emissions scandal.

Text Books:

1. Christoph Stückelberger, Pavan Duggal, "Data Ethics: Building Trust: How Digital Technologies Can Serve Humanity", Globethics Publications, 1st Edition, 2023.
2. Gry Hasselbalch & Pernille Tranberg, "Data Ethics", PubliShare, 1st Edition, 2016.

Reference Books:

1. Ian Foster, Rayid Ghani, Ron S. Jarmin, Frauke Kreuter, Julia Lane, "Big Data and Social Science: Data Science Methods and Tools for Research and Practice", Chapman and Hall/CRC, 2nd Edition, 2020.
2. Evren Eryurek, Uri Gilad, Valliappa Lakshmanan, "Data Governance: The Definitive Guide - People, Processes, and Tools to Operationalize Data Trustworthiness", Shroff/O'Reilly, 1st Edition, 2021.

3. Loukides, Mike, Hilary Mason, and DJ Patil, "Ethics and Data Science- Doing Good Data Science", Sebastopol, CA: O'Reilly Media., 2018.

4. Sandvig, Christian, Kevin Hamilton, Karrie Karahalios, and Cedric Langbort, "Auditing Algorithms: Research Methods for Detecting Discrimination on Internet Platforms", Computational Culture, 2014.

5. Ananny, Mike, "Toward an Ethics of Algorithms : Convening Observation , Probability and Timeliness." Science, Technology, & Human Values vol. 41 no. 1, pp. 93–117, 2016.

Web Links:

1. Ethics in Data Science: https://www.analyticsvidhya.com/blog/2022/02/ethics-in-data-science-and-proper-privacy-and-usage-of-data/

2. Business Insights Harvard: https://online.hbs.edu/blog/post/data-ethics

3. Data Science Professionals: https://emeritus.org/blog/data-science-and-analytics-data-science-course-curriculum/

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech	Semester: VIII
Geo-Spatial Data Science (PECS8023T)		

Prerequisite: Data Visualization, Machine Learning, Artificial Intelligence

Course Objective(s):

This course will introduce students to the field of geospatial data science, covering the fundamental concepts, tools, and techniques used to analyze and visualize geospatial data. Students will gain hands-on experience in working with geospatial data and applying data science methods to solve real-world problems.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply tools and techniques used to analyze and visualize geospatial data.	L3	Apply
CO2	Apply data science methods to solve real-world problems with geospatial data.	L3	Apply
CO3	Analyze geospatial large data models and ethical issues.	L4	Analyze

Geo-Spatial Data Science (PECS8023T)
Course Contents

Unit-I 06 Hrs.

Introduction to Geospatial Data: Introduction to Geographic Information Systems (GIS), Data Collection and Sources, Remote sensing and satellite imagery, GPS data and tracking, network, Coordinate systems and projections, Overview of geospatial data: Coordinates, attributes, temporal information; static and dynamic data, Spatial Data Types: vector and raster data, network data, and its GSD applications and Spatial Data Formats: shapefiles, geodatabases, Spatial data structures.

Unit-II 08 Hrs.

Geospatial Data Modeling: Feature based approach: points, lines, polygon, curve, surface, geometry collection; Algebra and calculi of qualitative spatial relations, topological relations RCC-8, cardinal directions, Field based approach. Spatial regression, clustering, and optimization, Geostatistics and spatial modeling, Predictive modeling with geospatial data, Case study: Predicting property values, Spatial Analysis, Buffer analysis, spatial joins.

Unit-III 09 Hrs.

Linked Geospatial Data: Visualizing Linked Geospatial Data, Querying Geospatial Data Expressed in RDF, Transforming Geospatial Data into RDF, SPARQL, Interlinking Geospatial Data Sources, Incomplete Geospatial Information, Geospatial RDF stores, Geospatial Knowledge Graphs, Question Answering Engines for Geospatial Knowledge Graphs, choropleth mapping.

Unit-IV 07 Hrs.

Geospatial Visualization: Introduction to data visualization libraries (e.g., Matplotlib, Folium, Plotly), Creating basic maps and charts, customizing geospatial visualizations, creating maps and charts, Customizing geospatial visualizations Python toolkits Geospatial Visualization. Spatial Data, GIS, Geospatial Data, Geospatial Analysis, Data Visualization.

Unit-V 06 Hrs.

Data Ingestion & Big Data: Web scraping and APIs, work effectively with the geo spatial large datasets.

Spatial Analysis: Spatial queries and operations.

Unit-VI 06 Hrs.

GIS Software: Introduction to web mapping tools (e.g., Leaflet), Exploring GIS software (QGIS, ArcGIS), Introduction to geospatial libraries (e.g., Geopandas, Fiona, Shapely), Buildin

teractive web maps, Geospatial big data and distributed computing, Machine learning for geospatial data, Geo Spatial Data Ethics, Ethical considerations in geospatial data analysis

Text Books:

1. David S. Jordan, "Applied Geospatial Data Science with Python", Association of Computing Machinery, 1st Edition, 2023.
2. Manolis Koubarakis, "Geospatial Data Science: A Hands-on Approach for Building Geospatial Applications Using Linked Data Technologies", Association of Computing Machinery, 1st Edition, 2023.
3. Hassan A. Karimi, Bobak Karimi, "Geospatial Data Science Techniques and Applications", CRC Press, 1st Edition, 2020.
4. Kang-Tsung Chang, "Introduction to Geographic Information Systems", McGraw-Hill Education, 4th Edition, 2019.
5. Tyler Mitchell, "Web Mapping Illustrated", O'Reilly Media, 1st Edition, 2010.
6. Janahan Gnanachandran, "Geospatial data analysis on AWS", ACM Publisher, 1st Edition, 2023.

Reference Books:

1. Chris Garrard, "Geoprocessing with Python", Manning Publisher, 1st Edition, 2016.
2. Paul Crickard, "Leaflet.js Essentials", Packt Publishing Ltd, llustrated edition, 2014.
3. Michael J. de Smith, Michael F. Goodchild, and Paul A. Longley, "Geospatial Analysis: A Comprehensive Guide", Winchelsea Press, 1st Edition, 2018.

Web Links:

1. The Ultimate Guide to Geospatial Data Science, Geospatial Data Science Explained: A Full Guide - Aya Data

Program: Computer Science & Engineering (Data Science)	Final Year B.Tech.	Semester: VIII
Internship (INTCS8030L)		

Course Objective(s):

1. To expose technically students for the industrial environment, allowing them to gain real-world experience and develop into competent professionals.
2. To provide opportunities to learn and enhance the practical technical skills required for professional roles.
3. To familiarize students with current technological developments relevant to their field of study.
4. To develop technical writing skills for reports and projects.
5. To introduce students to the responsibilities and ethics of the engineering profession.
6. To develop an understanding of employee psychology, habits, attitudes, and problem-solving approaches.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply theoretical knowledge to real-world engineering problems through hands-on experience in industry or field settings.	L3	Apply
CO2	Apply technical knowledge and problem-solving approaches to address complex engineering problems in an industrial environment.	L2	Apply
CO3	Analyze organizational structures, workflows, and technologies to understand industry practices and operational challenges.	L4	Analyze
CO4	Develop technical documentation, reports, and presentations reflecting experiential learning and problem-solving approaches.	L6	Create
CO5	Discuss career goals and identify areas for personal and professional development based on internship exposure.	L2	Underst

Internships offer valuable educational and career development opportunities by providing students with practical experience in their field of study. In Semester–VIII, students have two options for their internship: Industry Internship and In-house Internship.

1. Industry Internship

Industry Internship Guidelines:

- The Training and Placement (T&P) cell of the institute will arrange internships for students in industries/organizations after the seventh semester.
- Students are expected to accept internship offers regardless of the company, job profile, location, or stipend offered.
- Alternatively, students can individually apply by submitting "Student Internship Program Application" (available on Institute Website) for industry internships, adhering to the prescribed guidelines as follows:
    1. Only T&P department granted internship will be considered.
    2. The internship duration should be of minimum 12 Weeks.
    3. Each student needs to take prior permission from T&P department before proceeding for any internship opportunity on his/her own.
    4. Each student will be monitored twice (virtually/through online meetings) during the internship period in the presence of an industry mentor and the departmental faculty mentor and the concerned TPC.
    5. If any student wants to withdraw from the Internship, he/she can only be allowed within two weeks of joining the same. Such students will have to continue the semester VIII academic activities regularly along with In-house internship.

Expected Activity in Industry Internship:

- Students may choose to work on innovation or entrepreneurial activities resulting in start-ups or undergo internships with Industry/NGO/ Government organizations/Micro/ Small/ Medium enterprises to prepare for the industry.
- Every student is required to prepare a file containing documentary proofs of the activities done by him/her. The evaluation of these activities will be done twice (virtually/through online meetings) during the internship period by the committee constituted by the Head of the Department which shall include Industry mentor, faculty mentor and Department T&P Co-ordinator (TPC). The assessment criteria for continuous assessment is as per Table 4.
- The ESE will be jointly evaluated by an industry mentor, faculty member and department T&P coordinator (TPC). The evaluation criteria is as per Table 5.

Table 4: Continuous Assessment for Industry Internship

Internship Objectives and Goals (30 Marks)	**Internship Experience Skills Gained/Enhanced (30 Marks)**	**Professional Development and Growth (30 Marks)**	**Internship Report (30 Marks)**	**Presentation (30 Marks)**

Table 5: Evaluation Criteria of Industry Internship

Internship Objectives and Goals (30 Marks)	**Internship Experience Skills Gained/Enhanced (30 Marks)**	**Professional Development and Growth (30 Marks)**	**Internship Report (30 Marks)**	**Presentation (30 Marks)**

Industry Internship Report:

- Upon completion of the internship, students should prepare a comprehensive report that reflects their observations and learnings during the internship period. Students can consult their Industrial Supervisor, Faculty Mentor, or T&P Co-ordinator/Officer for guidance on selecting special topics and problems for the report.

- The internship report will be evaluated based on the following criteria:

  i. Adequacy and purposeful write-up.

  ii. Variety and relevance of learning experience.

  iii. Practical applications and connections with the fundamental theories and concepts covered in the course (Semester I to VII).

2. In-house Internship

The in-house internship provides students with research-oriented opportunities to cultivate a research mindset. It serves as an extension of the project completed in VI and VII semesters (Project Stage-I & II) or offers new objectives provided by the department or research guide.

1. The in-house internship can be pursued individually or as a group activity.
2. If extending a project from Stage II, at least one student in the group must have participated in Stage I & II.
3. If working on the topic offered by the department or in-house mentor, a group of fresh students can form a team.
4. The maximum group size is limited to four students.
5. In case of extension of project stage II, the outcomes should be in the form of product development/technology transfer along with patent and copyright / one research publication (UGC care listed journal/conference). Students can work jointly with any governi

funding agency or industry. In such cases, a detailed project report shall be submitted after verification by the in-house mentor and industry/funding agency mentor/authority. In case of standalone/non-sponsored activity, i.e. without any funding agency/industry collaboration, the detailed project report shall be submitted after verification by the in-house mentor.

6. If pursuing a Topic offered by the department or in-house mentor, the outcome of the in-house internship should include the publication of a research paper, preferably in an SCI/Scopus/UGC care listed/indexed Journal/Conference. The detailed project report must be submitted and verified by the in-house mentor.
7. All the designated work shall be submitted to the department in the form of a report in hardbound as well as soft copy.
8. **Evaluation Scheme:**

   I. Continuous Assessment:

   (a) A logbook (as per Table 6) of the work done must be maintained by each group.

   (b) Each in-house internship activity will be reviewed twice in the semester. In the first review (as per Table 7), at least 40% work shall be completed including the topic identification /introduction/scope of the work, literature survey, problem definition and objectives. The remaining 60% of work shall be completed in the second review (as per Table 8) including implementations, key findings, publications/ patenting/copyright/product development etc.

   II. End Semester Examination:

   End semester examination (as per Table 9) will be jointly evaluated by the faculty mentor and an external examiner appointed by the HOD in consultation with the COE.

9. **Assessment Formats:**

Table 6: Log Book Format

Sr	Week (Start Date: End Date)	Work Done	Sign of In-house mentor	Sign of Coordinator
1				

Table 7: First Review

Topic Identification & Validation (20 Marks)	Literature Survey (20 Marks)	Problem Definition (20 Marks)	Objectives (15 Marks)

Table 8: Second Review

Implementation (20 Marks)	**Publications (20 Marks)**	**Report (20 Marks)**	**Presentation (15 Marks)**

Table 9: End Semester Examination

Topic Identification & Validation (30 Marks)	**Literature Survey & Problem Definition (30 Marks)**	**Objectives & Implementation or Product Development (30 Marks)**	**Presentation (30 Marks)**	**Report, Publications/Patent/IPR Documents (30 Marks)**