Shirpur Education Society's

R. C. Patel Institute of Technology, Shirpur

(An Autonomous Institute)

Course Structure and Syllabus

Third Year B. Tech

Computer Science and Engineering (Data Science)

With effect from Year 2025-26

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

Third Year B. Tech Computer Science and Engineering (Data Science) Semester-VI (w.e.f. 2025-26)														
Sr	Course Cate-gory	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	RCP23DCPC601	Machine Learning-III (Reinforcement Learning)	3			25	15	15	15	60	100	3	4
	PC	RCP23DLPC601	Machine Learning-III (Reinforcement Learning) Laboratory			2	25					25	1	
2	PC	RCP23DCPC602	Natural Language Text Processing	3			25	15	15	15	60	100	3	4
	PC	RCP23DLPC602	Natural Language Text Processing Laboratory			2	25				25	50	1	
3	PC	RCP23DLPC603	Advanced Statistics Laboratory			4	50					50	2	2
4	MD	RCP23DLMD601	Applied Data Science Engineering Laboratory			2	25					25	1	1
5@	PE	RCP23DCPE611	Time Series Analysis	3			25	15	15	15	60	100	3	4
		RCP23DLPE611	Time Series Analysis Laboratory			2	25					25	1	
		RCP23DCPE612	Analysis of AI Algorithms	3			25	15	15	15	60	100	3	
		RCP23DLPE612	Analysis of AI Algorithms Laboratory			2	25					25	1	
		RCP23DCPE613	Medical Imaging Informatics and Inteoperability	3			25	15	15	15	60	100	3	
		RCP23DLPE613	Medical Imaging Informatics and Inteoperability Laboratory			2	25					25	1	
		RCP23DCPE614	Ethical Hacking and Digital Forensics	3			25	15	15	15	60	100	3	
		RCP23DLPE614	Ethical Hacking and Digital Forensics Laboratory			2	25					25	1	
6#	PE	RCP23DCPE621	Computer Vision	4			25	15	15	15	60	100	4	5
		RCP23DLPE621	Computer Vision Laboratory			2	25				25	50	1	
		RCP23DCPE622	Robotics and AI	4			25	15	15	15	60	100	4	
		RCP23DLPE622	Robotics and AI Laboratory			2	25				25	50	1	
		RCP23DCPE623	Applied Game Theory	4			25	15	15	15	60	100	4	
		RCP23DLPE623	Applied Game Theory Laboratory			2	25				25	50	1	
		RCP23DCPE624	Information Security	4			25	15	15	15	60	100	4	
		RCP23DLPE624	Information Security Laboratory			2	25				25	50	1	
7	EL	RCP23IPEL601	Project Stage-I			4	50				50	100	2	2
8	HS	RCP23ITHSX06	Environmental Science Tutorial		1		25					25	1	1
			Total	13	1	18	350			60	340	750	23	

@Any 1 Programme Elective Course from Set-1
#Any 1 Programme Elective Course from Set-2

Prepared by:
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Semester - VI

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech.	Semester: VI
Machine Learning – III (Reinforcement Learning) (RCP23DCPC601)		
Machine Learning – III (Reinforcement Learning) Laboratory (RCP23DLPC601)		

Prerequisite: Machine Learning-I, Machine Learning-II and Artificial Intelligence.

Course Objective(s):

1. To make students learn to build programs that act in a stochastic environment, based on past experience using various Reinforcement Learning methods.

Course Outcomes:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze basic and advanced Reinforcement Learning techniques.	L4	Analyze
CO2	Describe suitable learning tasks to which Reinforcement learning and Deep Reinforcement Learning techniques can be applied.	L2	Understand
CO3	Apply appropriate Reinforcement Learning method to solve a given problem.	L3	Apply

Machine Learning – III (Reinforcement Learning) (RCP23DCPC601) Course Contents

Unit-I 04 Hrs.

Introduction:

Reinforcement Learning (RL), Elements of Reinforcement Learning, Reinforcement Learning Vs Supervised Learning, Approaches of solving Reinforcement Learning: Value based, policy based, model based, Exploration - Exploitation dilemma, Evolutionary methods, Immediate Reinforcement Learning.

Unit-II 06 Hrs.

Immediate Reinforcement Learning:

Bandit Problems: Bandit problems, Value-action based methods (sample average), Greedy method, ϵ-greedy method, Incremental Implementation, Non-stationary problem, Optimistic Initial values, UCB algorithm, Thompson Sampling.

Policy Gradient Approaches: Linear reward Penalty Algorithm, Parameterized policy representation(θ), Evaluation of policy((θ)), REINFORCE algorithm.

Unit-III 08 Hrs.

Full Reinforcement Learning:

Difference between Immediate and Full Reinforcement Learning, Agents and Environment, Goals, Rewards, Returns, Policy in Full Reinforcement Learning, Episodic and Continuing Tasks.

Markov Decision Process (MDP)

Markov Property, Finite Markov Decision Process, Value functions, Bellman'sequations, optimal value functions, Definition of MDP in Reinforcement Learning, Solution of the Recycling Robot problem

Unit-IV 08 Hrs.

Dynamic Programing:

Policy evaluation, policy improvement, policy iteration, value iteration, Asynchronous Dynamic Programing, bootstrap, full back up.

Monte Carlo Method:

Advantages of Monte Carlo over Dynamic Programing, Monte Carlo Control, on-policy, off- policy, Incremental Monte Carlo, Issues/Assumptions in Monte Carlo Methods, Solution of BlackJack using Monte Carlo Method.

Unit-V 08 Hrs.

Temporal Difference Learning:

What is Temporal Difference learning, Advantages of Temporal Difference methods over Monte Carlo and Dynamic Programming methods, TD (0), On-policy vs off-policy, SARSA, Q learning.

Eligibility traces:

N-step Temporal Difference methods, On-line vs Off-line updation, TD(λ): forward view, backward view, Traces: Accumulating trace, Dutch trace, Replacing trace, Equivalence of forward and backward view, SARSA(λ).

Unit-VI 08 Hrs.

Deep Reinforcement Learning:

Function Approximation:

Drawbacks of tabular implementation, Function Approximation, Gradient Descent Methods, Linear parameterization, Policy gradient with function approximation.

Deep Reinforcement Learning:

Intro of Deep Learning in Reinforcement Learning, Deep learning training workflow, Categories of Deep learning, Deep Q-Network, Ways of improving Deep Q-Network, REINFORCE in Full Reinforcement Learning, Actor-Critic Algorithm, A2C, A3C, DDPG. Proximal Policy Optimization (PPO).

Machine Learning – III (Reinforcement Learning) (RCP23DLPC601)

List of Laboratory Experiments

Suggested Experiments(At Least 08)

1. Bandit Problem:
   - Implement Greedy and Epsilon greedy methods.
   - Comparison between Greedy and Epsilon Greedy Policy.
   - UCB: Upper Confidence Bound.
2. Policy Gradient (Convergence)
   - Implement REINFORCE algorithm on a CartPole/ Lunar Lander.
3. Dynamic Programming and Monte Carlo Methods.
   - Implementation of GridWorld using Dynamic Programming.
   - Jack's Car Rental using Dynamic Programming.
   - Gamblers Problem using Dynamic Programming.

- BlackJack using Monte Carlo.
- Race Track Problem.

4. Temporal Difference.
   - Implement Frozen Lake using SARSA.
   - Implement Grid world using Q learning.

5. Deep Reinforcement Learning.
   - Compare the performance of Reinforcement Learning and Deep Reinforcement Learning on a Cart pole. problem.
   - Implementation of Deep Q-Network algorithm.
   - Actor Critic: Find the optimal policy using the Actor Critic method.
   - Analyze the effects of PPO's clipping parameter and learning rate on policy stability and convergence

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

Text Books:

1. Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning: An Introduction", MIT Press, 2nd Edition, 2022.
2. Laura Graesser Wah Loon Keng, "Foundations of Deep Reinforcement Learning", Pearson Education, 1st Edition, 2020.

Reference Books:

1. Phil Winder, "Reinforcement Learning Industrial Applications of Intelligent Agents", O'Reilly, 1st Edition, 2020.
2. Csaba Szepesvari, "Algorithms for Reinforcement Learning," Morgan Claypool Publishers, 1st Edition, 2019.
3. Enes Bilgin, "Mastering Reinforcement Learning with Python", Packt publication, 1st Edition, 2020.
4. Brandon Brown, Alexander Zai, "Deep Reinforcement Learning in Action", Manning Publications, 1st Edition, 2020.
5. Micheal Lanham, "Hands-On Reinforcement Learning for Games," Packt Publishing, 1st Edition, 2020

6. Abhishek Nandy, Manisha Biswas, "Reinforcement Learning: With Open AI, TensorFlow and Keras using Python," Apress, 1st Edition, 2018.

Web Links:

1. NPTEL Course in Reinforcement Learning: https://onlinecourses.nptel.ac.in/noc22 cs75/preview
2. Reinforcement Learning Course (Stanford University): https://www.youtube.com/watch?v=FgzM3zpZ55o
3. AI Games with Deep Reinforcement Learning: https://towardsdatascience.com/how-to-teachan-ai- to-play-games-deep reinforcement-learning-28f9b920440a
4. Deep Reinforcement Learning: https://www.v7labs.com/blog/deep-reinforcement-learning-guide

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech.	Semester: VI
Natural Language Text Processing (RCP23DCPC602)		
Natural Language Text Processing Laboratory (RCP23DLPC602)		

Prerequisite: Machine Learning-II, Foundations of Data Analysis, Statistics for Data Science.

Course Objective(s):

1. To introduce basics of language computation fundamental through morphological computation, syntax,semantic and discourse analysis. Apply these concepts to develop Computational Models for Real World Applications.

Course Outcomes:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply appropriate pre-processing techniques on linguistic data.	L3	Apply
CO2	Analyze different Machine Learning and deep learning algorithms to develop applications based on natural language processing.	L4	Analyze
CO3	Evaluate Natural Language Processing Applications.	L5	Evaluate

Natural Language Text Processing (RCP23DCPC602)
Course Contents

Unit-I — 05 Hrs.

Introduction:

Generic Natural Language Processing (NLP) system, levels of NLP, Knowledge in language processing, Ambiguity in Natural language, stages in NLP, challenges of NLP, Applications of NLP Machine Translation, Sentiment Analysis etc.

Text Processing:

Word Tokenization and Segmentation, Lemmatization, Bag of words, N-gram language model, N-gram for spelling correction. Edit distance – Dynamic Programming Approach, Weighted Edit Distance, Finding Dictionary Entries with Small Edit Distances, Noisy Channel Model, Non-word errors Real-word errors. Evaluation of Language Models, Basic Smoothing, Advanced Smoothing Models. Advanced: Perplexity's Relation to Entropy.

Unit-II — 09 Hrs.

Computational Semantics and Semantic Parsing:

Vector Semantics: Words and Vectors, Term Frequency-Inverse Document Frequency (TFIDF), Word2vec, Continuous Bag of Words, ELMO, GloVe Vector Visualizing Embedding's, Semantic properties of embedding's, Bias and Embedding's Evaluating Vector Models, Cosine for measuring similarity, Pointwise Mutual Information (PMI), PPMI vector models.

Lexical Semantics: Word Senses -Relations Between Senses, WordNet: A Database of Lexical Relations, Word Sense Disambiguation Alternate WSD algorithms and Tasks.

Unit-III — 05 Hrs.

Text Classification:

Text classification definition and datasets, Generative text classifiers (Naïve Bayes) Discriminative text classifiers (Support Vector Machine), Bag-of-words Generative Classifier, BOW Discriminative Model, Multi-class Classification: Softmax, Gradient Descent, Statistical significance testing, Dataset understanding and creation.

Unit-IV — 07 Hrs.

Recurrent Neural Networks:

Recurrent Neural Network, RNNs as Language, RNNs for Sequence Classification, Stacked Recurrent Neural network, Bidirectional RNNs, Managing Context in RNNs: Long Short-Term Memory (LSTMs) and gated Recurrent Unit (GRUs).

Unit-V 12 Hrs.

Computational Morphology and Syntax Analysis:

Computational Morphology:

Morphological Processes, Morphological Analysis- Inflectional morphology Derivational morphology, Regular expression, Finite State Automata, Finite State Transducer, Morphological parsing with FST, Lexicon free FST Porter stemmer, and two-level morphology.

Syntax Analysis:

Introduction to POS Tagging, Probabilistic Tagging, Markov Models, Hidden Markov Models (HMM) for POS Tagging, Conditional Random Fields (CRF), Named Entities and Named Entity Tagging, Context-Free Grammars-Derivation, Constituency Parsing, Dependency Parsing.

Unit-VI 4 Hrs.

Discourse Coherence:

Coherence Relation, Discourse Structure Parsing, Centring and Entity-Based Coherence, Global Coherence.

Natural Language Text Processing Laboratory (RCP23DLPC602)

List of Laboratory Experiments

Suggested Experiments(At Least 08)

1. Perform Pre-processing steps in Natural language Processing (Tokenization, Stop Word detection, Stemming and Lemmatization.
2. Implement Parts of Speech tagging using HMM
3. Implement word-embedding and TF-IDF vectors in Natural language Processing
4. Implement language model using Ngram language model
5. Generate recursive set of sentences using Context Free Grammar. Identify the word senses using "synset" in NLTK
6. Implement Spelling Check, Spelling Correction and Auto complete using Language models or CFG.
7. Implement a Spam classifier in Natural Language Processing
8. Implement Fake News Classifier Using LSTM-Deep Learning in NLP
9. Implement a Sentiment Analysis in Natural Language Processing

10. Implement NLP application on Regional Language
11. Implement Question Answering in NLP
12. Implement Chatbot in NLP
13. Implement Information Retrieval for extracting Text from Webpages and Images
14. Mini Project

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

Weblinks:

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

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech.	Semester: VI
Advanced Statistics Laboratory (RCP23DLPC603)		

Prerequisite: Statistics for Data Science, Python and Machine Learning.

Course Objective(s):

1. This course introduces the theoretical and computational foundations of statistical inference, covering parameter estimation, hypothesis testing, and model diagnostics. It integrates classical, Bayesian, and nonparametric approaches with resampling and model assessment techniques to enable robust, data-driven decision-making.

Course Outcomes:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Interpret and evaluate estimators under classical and Bayesian paradigms.	L2	Understand
CO2	Apply and interpret hypothesis tests for linear and logistic regression models.	L3	Apply
CO3	Apply nonparametric testing methods when parametric assumptions fail.	L3	Apply
CO4	Examine model performance and generalization.	L3	Apply
CO5	Use statistical reasoning with computational implementation.	L3	Apply

Advanced Statistics Laboratory (RCP23DLPC603) Course Contents

Unit-I — 06 Hrs.

Estimation Theory Fundamentals:

- Estimation of Parameters using Maximum Likelihood Estimation (MLE) and Method of Moments.
- Estimate μ for a Normal (μ, σ^2) using MLE and compute Cramér–Rao Lower Bound (CRLB).
- Derive MLE for Bernoulli(p), Normal Distributions and analyze estimator properties.

Unit-II — 04 Hrs.

Linear Regression Inference & Hypothesis Testing:

- Fit and Evaluate a Simple Linear Regression Model using t-test, F-test, and Confidence Intervals for Coefficients.
- Compare Nested and Non-Nested Regression Models using Likelihood Ratio, AIC, and BIC Criteria.

Unit-III — 04 Hrs.

Regression Diagnostics and Model Assumptions:

- Perform Regression Diagnostics: Multicollinearity (VIF) and Normality Tests on Residuals.
- Detect and Correct Heteroscedasticity using Breusch–Pagan Test, White Test, and Log/Weighted Least Squares Transformations.

Unit-IV — 06 Hrs.

Logistic Regression and GLMs:

- Estimate and Interpret Logistic Regression Coefficients, Odds Ratios, and Model Fit using Hosmer–Lemeshow Test and Pseudo-R^2.
- Extend Logistic Regression to Generalized Linear Models (GLMs) using Different Link Functions and Evaluate Model Deviance.

Unit-V — 6 Hrs.

Multinomial Logistic and Generalized Models:

- Model Count Data using Poisson Regression under the Generalized Linear Models (GLMs) Framework.

- Fit and Interpret Multinomial and Ordinal Logistic Regression Models.
- Compare Logit and Probit Link Functions within the Exponential Family of GLMs.

Unit-VI 06 Hrs.

Nonparametric Hypothesis Testing:

- Compare Two Independent Samples using Mann–Whitney U and Wilcoxon Rank-Sum Tests.
- Perform Goodness-of-Fit Testing using Kolmogorov–Smirnov and Chi-Square Tests.
- Construct Bootstrap-Based Confidence Intervals and Conduct Nonparametric Inference.

Unit-VII 04 Hrs.

Bayesian Inference:

- Perform Bayesian Estimation for Normal and Binomial Models using Conjugate Priors and Credible Intervals.

Unit-VIII 04 Hrs.

Markov Chain Monte Carlo (MCMC) Techniques :

- Implement MCMC Methods (Metropolis–Hastings and Gibbs Sampling) for Posterior Inference using PyMC/Stan.
- Analyze Convergence Diagnostics and Visualize Posterior Distributions using Trace and Density Plots.

Unit-IX 02 Hrs.

Advanced Bayesian Methods:

- Perform Bayesian Regression.
- Model Comparison using Posterior Predictive Checks and Information Criteria.
- Model Comparison (e.g., WAIC, LOO).

Unit-X 02 Hrs.

Bayesian Hypothesis Testing:

- Bayes Factors (BF and BF)
- Posterior Odds vs. Prior Odds
- Evidence Interpretation Scale (Jeffreys scale)
- Bayesian One-Sample Two-Sample Tests (Mean difference)
- Bayesian A/B Testing (Beta-Binomial model)

- Hypothesis Testing using Credible Intervals

Unit-XI 06 Hrs.

Uncertainty Quantification and Resampling:

- Integrate Frequentist, Bayesian, and Resampling Approaches using Cross-Validation, Bootstrapping, and Permutation Methods.
- Quantify Uncertainty through Confidence vs. Credible Intervals and Posterior Predictive Checks.
- Integrate Frequentist, Bayesian, and Resampling Approaches using Cross-Validation, Bootstrapping, and Permutation Methods.

Unit-XII 02 Hrs.

High-Dimensional Inference:

- Perform High-Dimensional Inference with Multiple Testing Corrections.
- Benjamini–Hochberg FDR.

Unit-XIII 04 Hrs.

Causal Inference, and Regularization Techniques:

- Apply Causal Inference and Regularization Methods:
- Propensity Scores.
- Instrumental Variables
- Ridge, Lasso, and Elastic Net.

Text Books:

1. G. Casella R. L. Berger, "Statistical Inference", 2nd Edition, Cengage Learning (2021).
2. Gelman, J. B. Carlin, H. S. Stern, D. B. Dunson, A. Vehtari, and D. B. Rubin, "Bayesian Data Analysis", CRC Press, 4rd Edition, 2025.
3. B. Efron and R. J. Tibshirani, "An Introduction to the Bootstrap, Chapman" & Hall/CRC, Reprint Edition, 2003.
4. Agresti, "Categorical Data Analysis", Wiley, 3rd Edition, 2013.

Reference Books:

1. G. James, D. Witten, T. Hastie, and R. Tibshirani, "An Introduction to Statistical Learning with Applications in R", Springer, 2nd Edition, 2021.
2. C. M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.

3. R. McElreath, "Statistical Rethinking: A Bayesian Course with Examples in R and Stan", CRC Press, 2nd Edition, 2020.

4. C. Davison and D. V. Hinkley, "Bootstrap Methods and Their Application", Cambridge University Press, Reprint Edition, 2006.

Web Links:

1. L. Wasserman, All of Statistics: A Concise Course in Statistical Inference, Springer, 2004. All of Statistics: A Concise Course in Statistical Inference — SpringerLink

2. Bayesian Data Analysis in Python Course with Datacamp. Data Analytics A-Z with Python — Udemy

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech.	Semester: VI
Applied Data Science Engineering Laboratory (RCP23DLMD601)		

Prerequisite: Foundations of Data Analysis, Database Systems, Python Laboratory.

Course Objective(s):

1. To introduce students to the fundamentals of big data processing, analytics, and performance monitoring tools.

Course Outcomes:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze large-scale datasets on real-time messaging work-flows using Hadoop, HDFS, MapReduce, and AMPS.	L4	Analyze
CO2	Develop data processing pipelines using ML models, and evaluate model drift using Apache Spark.	L6	Create
CO3	Evaluate system metrics, KPIs, and workflows using Prometheus, Grafana, and Apache Airflow.	L5	Evaluate

Applied Data Science Engineering Laboratory (RCP23DLMD601)

Course Contents

Unit-I — 02 Hrs.

Introduction to Big Data and Hadoop:

- Big Data Concepts and Hadoop Architecture.
- Core Hadoop Components.
- Hadoop Ecosystem.
- Data profiling and documentation (EDA).

Unit-II — 02 Hrs.

Hadoop Distributed File System:

- Understand Hadoop Distributed File System (HDFS) architecture and commands.
- Introduction to MapReduce.
- Write and run a basic MapReduce program (WordCount).
- View MapReduce job output and logs.

Unit-III — 04 Hrs.

Messaging Services using AMPS:

- Real-time messaging using AMPS.
- Pub / Sub models.
- Using SOW Topics and Historical Replay in AMPS.
- Filtering, Message Queuing and Expiration/Acknowledgement in AMPS.
- Complete Real-Time Messaging Workflow with AMPS: From Publish to SOW.

Unit-IV — 04 Hrs.

Introduction to Apache Spark:

- Apache Spark ecosystem.
- Setup and shell.

- Setup and shell.
- Real-time and Batch processing of high volume of data.
- Processing high volume records in-memory (SQL).

Unit-V 4 Hrs.

Data analytics and Visualization:

- Spark Dataframe
- Build a classification pipeline using MLlib.
- Apply feature transformers/regression model.
- Data visualization using GraphX / Graph Frames.

Unit-VI 02 Hrs.

Model Drift:

- Introduction to Model Drift.
- Types of Model Drift.
- Drift Detection Techniques: Statistical tests, PSI, and distribution analysis.
- Implementing Drift Detection using Apache Spark.

Unit-VII 02 Hrs.

Prometheus – Metric Instrumentation and Monitoring:

- Learn to install and configure Prometheus
- Instrument an application or system for metrics collection
- Scrape metrics using Prometheus.
- Configure alerts using Alertmanager.

Unit-VIII 02 Hrs.

Grafana – Dashboard Visualization:

- Connect Grafana to Prometheus data source.
- Create dashboards with time-series graphs, heatmaps, and charts.
- Configure alerts in Grafana dashboards
- Visualize trends and analyze system/application performance

Unit-IX 02 Hrs.

Performance Indicator:

- Gather structured data from Grafana dashboards.
- Identify all Key performance indicators (KPIs).
- Build a KPI matrix linking technical, operational, and business KPIs.
- Present KPIs as insights to business stakeholders.

Unit-X 04 Hrs.

Apache Airflow:

- Install and configure Apache Airflow
- Create a Cron-based scheduled workflow (Airflow Cron Job).
- Configure and schedule a recurring job using Cron expressions.
- Monitor DAG execution performance through Airflow's UI.

Text Books:

1. Thompson Carter," Big Data with Hadoop and Spark: Analyze Massive Datasets with Apache Hadoop, Spark, and NoSQL" , 2024.
2. Steven L. Brunton , J. Nathan Kutz, "Data Driven Science and Engineering: Machine Learning, Dynamical Systems, and Control" , Cambridge University Press (2nd Edition 2022).

Reference Books:

1. Tanvir Habib Sardar , Bishwajeet Kumar Pandey, "Big Data Computing: Advances in Technologies, Methodologies, and Applications", 2023.
2. William Hegedus, "Mastering Prometheus", 2024.
3. Julian de Ruiter, Ismael Cabral, "Data Pipelines with Apache Airflow", Second Edition, 2024.

Web Links:

1. https://www.udemy.com/course/grafana-tutorial
2. https://www.pluralsight.com/courses/prometheus-grafana-building-dashboards-data
3. https://airflow.apache.org/

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech.	Semester: VI
Time Series Analysis (RCP23DCPE611)		
Time Series Analysis Laboratory (RCP23DLPE611)		

Prerequisite: Probability, Statistics and Linear Models.

Course Objective(s):

1. Learn basic analysis of time series data; concepts in time series regression, auto-regressive and model averaging models, learn basic concepts of spectral analysis and space-time models.

Course Outcomes:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Interpret a correlogram and a sample spectrum	L2	Understand
CO2	Apply appropriate model for a time series dataset.	L3	Apply
CO3	Calculate forecasts for a variety of linear and non-linear methods and models.	L3	Apply

Time Series Analysis (RCP23DCPE611)
Course Contents

Unit-I 06 Hrs.

Introduction:

Types of forecasting methods, Types of Time Series, simple descriptive techniques, trends in time series (Parametric trends, differencing, nonparametric methods, noise), seasonality.

Stationary Time Series:

Formal definition of a time series, the sample mean and its standard error, Stationary processes: types of stationarity, statistical inference of time series.

Unit-II 06 Hrs.

Linear Time Series:

Motivation, Linear time series and moving average models, The AR model, simulating from an autoregressive process, The ARMA model, The ARIMA model, Unit roots, integrated and non-invertible processes, Box – Jenkins Model Selection, Seasonality, The SARIMA model.

Unit-III 08 Hrs.

Prediction:

Using prediction in estimating, forecasting for autoregressive processes, forecasting for AR, forecasting for general time series using infinite past, One-step ahead predictors based on the finite past: Levinson -Durbin algorithm; Forecasting for ARMA processes, State space model, The Kalman filter.

Automated Forecasting Systems:

Auto-ARIMA, Auto Prophet, Auto ML for time series, Integration of Auto ML and Hashing for Time Series Forecasting.

Unit-IV 10 Hrs.

Models with Trend:

Removing trend, Unit Root and Regression Residuals, The Monte Carlo Method, Dickey-Fuller tests.

Multi equation Time Series Models:

Intervention Analysis, ADLs and Transfer Functions, Introduction to VAR, Vector Error Correction Model (VECM), Structural VAR (SVAR), Time-Varying Parameter VAR, Bayesian VAR (BVAR).

Unit-V 6 Hrs.

Multivariate Time Series:

Background: Sequences and Functions, Convolution, Spectral Representations and mean squared errors; Multivariate time series regression: Conditional independence, Partial correlation and coherency between time series.

Unit-VI 06 Hrs.

Non Linear Time series:

The ARCH model: Feature of an ARCH, Existence of a strictly stationary solution, The GARCH model: Existence of stationary solution of a GARCH(1,1) and Bilinear models: Bilinear auto regression model(BAR), Advanced Nonlinear Models: Stochastic Volatility (SV) models, Nonlinear Autoregressive Models (NAR, NARX).

Time Series Analysis Laboratory (RCP23DLPE611)

List of Laboratory Experiments

Suggested Experiments (Any 08)

1. Time Series Characteristics: Time Series Data, Cross-Section Data, Panel data/ Longitudinal data.
2. Trends: (1) Detecting trends using Hodrick -Prescott Filter. (2) Detrending a Time Series
3. Seasonality: (1) Multiple Box Plots (2) Autocorrelation Plot (3) Deseasoning of Time-Series Data (4) Seasonal Decomposition (5) Detecting Cyclic Variations
4. Data Wrangling and Preparation for Time Series Data.
5. Smoothing Methods: Simple exponential, Double exponential and Triple exponential.
6. Making Data Stationary: Plots, Summary Statistics, Statistics Unit Root Tests, Augmented Dickey – Fuller Test.
7. Automated Forecasting Systems using Auto-ARIMA.
8. Prophet, AutoML.
9. Multivariate Time Series Analysis using VAR,VECM,SVAR modeling
10. Evaluation and Model Selection for Time Series Forecasting (Compare ARIMA vs XGBoost vs other candidate models using metrics like RMSE, MAE, and MAPE).

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

Text Books:

1. Walter Enders," Applied Econometric Time Series" , Fourth Edition, Wiley, 2014.
2. B. V. Vishwas and Ashish Patel, "Hands-on Time Series Analysis with Python", First Edition, Apress, 2020.

Reference Books:

1. Chris Chatfield, "Time- Series Forecasting", First Edition, Chapman Hall/CRC, 2001.
2. Douglas C. Montgomery, Cheryl L. Jennings and Nurat Kulahci, "Introduction to Time Series Analysis and Forecasting", Second Edition, Wiley, 2015.
3. Aileen Nielsen, "Practical Time Series Analysis", O'Reilly, 2019.
4. James D Hamilton, "Time Series Analysis", Princeton University Press, 1994.
5. Robert H. Shumway and David S. Stoffer, "Time Series Analysis and Its Applications", Springer, 2000.

Web Links:

1. A course on Time Series Analysis. https://caciitg.com/resources/tsa/
2. A comprehensive guide to Time Series Analysis. https://www.analyticsvidhya.com/blog/2021/10/a-comprehensive-guide-to-time-series-analysis/
3. The Complete Guide to Time Series Analysis and Forecasting. https://towardsdatascience.com/the-complete- guide-to-time-series-analysis-and-forecasting-70d476bfe775

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech.	Semester: VI
Analysis of AI Algorithms (RCP23DCPE612)		
Analysis of AI Algorithms Laboratory (RCP23DLPE612)		

Prerequisite: Data Structures, Design and Analysis of algorithms, Machine Learning.

Course Objective(s):

1. The course aims to develop analytical skills to understand algorithmic foundations, complexity, and performance trade-offs in designing efficient intelligent systems. It also equips students to apply, analyze, and evaluate data structures, optimization, probabilistic, randomized, and approximation algorithms for solving computationally complex AI problems effectively.

Course Outcomes:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze algorithmic and computational complexity foundations, including time–space trade-offs and machine-learning model complexities during training and testing phases.	L4	Analyze
CO2	Apply various searching, indexing, and data-structuring techniques such as hash-based search, trees, graphs, and spatial indices to develop efficient retrieval and reasoning systems in AI.	L3	Apply
CO3	Evaluate advanced optimization, probabilistic, randomized, and approximation algorithms to address complex AI problems considering efficiency, convergence, and scalability aspects.	L5	Evaluate

Analysis of AI Algorithms (RCP23DCPE612) Course Contents

Unit-I 04 Hrs.

Algorithmic and Complexity Foundations:

Review of algorithm analysis: Time and space complexity Complexity classes: P, NP, NP-hard, NP-complete Trade-offs in AI algorithm design (accuracy, scalability, efficiency)

Complexity Analysis of Machine Learning Algorithms:

Training Time Complexity and Testing Time Complexity Train/Test Complexity of Linear Regression Train/Test Complexity of Random Forest Train/Test Complexity of Naïve Bayes Classifier Train/Test Complexity of SVM

Unit-II 06 Hrs.

Searching and Indexing for AI:

Linear, Binary, Hash-based Searching, Heuristic Search, Search problems: Sliding tile puzzles, the Rubik's Cube, Sokoban, Inverted index and TF-IDF Vector space models and similarity search. High-dimensional indexing: KD-Trees, Ball Trees, Approximate Nearest Neighbor (ANN) search and LSH, Modern AI retrieval systems - IVF, FNSW/HNSW (FAISS, Annoy, ScaNN).

Unit-III 08 Hrs.

Graphs and Trees in AI:

Flow networks and Ford–Fulkerson algorithm, Bipartite matching and Hungarian algorithm, Minimum spanning trees and disjoint sets. Tries, Tango tree, R Tree, Splay Tree, 2-3 Tree, Max spanning Tree, Binomial tree, and Binomial Heap, Operations on binomial heap.

Unit-IV 12 Hrs.

Optimization Algorithms:

Kernel Trick, Advanced First-Order Optimization Methods: Momentum and Gradient Methods (MGD, NAG, AdaGrad, RMSProp) Quasi Newton's Method, Hessian Approximation. (BFGS / L-BFGS) Swarm-based algorithms: PSO, ACO, GA, Differential Evolution Exploration vs. exploitation, convergence, and complexity trade-offs

Unit-V 6 Hrs.

Probabilistic Randomized Algorithms:

Probabilistic data structures: Bloom Filters, Count-Min Sketch, LogLog and HyperLogLog, random projections, and the Johnson–Lindenstrauss Lemma Randomized Algorithms: Monte Carlo and Las Vegas algorithm, Randomized gradient methods, Randomized matrix algorithms and sketching, Markov Chain Monte Carlo (MCMC), Gibbs sampling.

Unit-VI 06 Hrs.

Approximation Algorithms:

Approximation ratios and performance bounds, Low-rank matrix decomposition (SVD, PCA, NMF), Semi-definite programming and convex relaxations Applications in recommendation systems and clustering

Analysis of AI Algorithms Laboratory (RCP23DLPE612)

List of Laboratory Experiments

Suggested Experiments (Any 08)

1. Analyze and demonstrate how kernel functions map data to higher dimensions for better separability.
2. Analyze the implementation of Gradient Descent, Momentum, and Nesterov Accelerated Gradient (NAG) and compare their convergence speeds.
3. Analyze the Ford–Fulkerson algorithm by implementing it for a given flow network and evaluating how it determines the maximum flow.
4. Analyze Quasi-Newton optimization by implementing it and comparing its convergence behavior against first-order methods.
5. Analyze swarm-based optimization algorithms through implementation and evaluation of their search dynamics.
6. Analyze the structure of a 2–3 tree by implementing insertion, split, and deletion operations and validating balancing invariants under random inputs.
7. Analyze an R-Tree by designing and implementing it for multidimensional spatial indexing and evaluating its performance on range and nearest-neighbor queries.
8. Analyze Binomial Trees of various orders by constructing them and verifying their structural properties.
9. Analyze a randomized rounding algorithm by implementing it and evaluating its approximation quality.
10. Analyze differences between Monte Carlo and Las Vegas algorithms by implementing them on a sample problem and comparing probabilistic accuracy and runtime behavior.

11. Analyze the MAX-CUT problem by applying SDP relaxation and randomized rounding to evaluate approximation performance.

12. Analyze low-rank approximation techniques such as SVD, Tucker, or Tensor Train decomposition by implementing them and examining reconstruction error.

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

Text Books:

1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw- Hill, 1st Edition, 2023.

2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, "Introduction to Algorithms", 4th Edition, The MIT Press, 2022.

3. Daphne Koller, Nir Friedman, "Probabilistic Graphical Models: Principles and Techniques", 2018.

Reference Books:

1. Vijay V. Vazirani, "Approximation Algorithms", 2021 (New edition).

2. Bruce Croft, Donald Metzler, Trevor Strohman "Search Engines: Information Retrieval in Practice" , 3rd Edition, 2019.

3. Rajeev Motwani, Prabhakar Raghavan "Randomized Algorithms", 2020

Web Links:

1. https://www.coursera.org/learn/advanced-algorithms-and-complexity

2. https://onlinecourses.nptel.ac.in/noc23_cs64/preview

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech.	Semester: VI
Medical Imaging Informatics and Inteoperability (RCP23DCPE613)		
Medical Imaging Informatics and Inteoperability Laboratory (RCP23DLPE613)		

Prerequisite: Machine Learning, Cloud Computing and Security.

Course Objective(s):

1. To equip students with the skills to understand medical imaging and digital pathology workflows, apply interoperability standards like HL7 v2.x, FHIR, and DICOM, and evaluate enterprise imaging systems including PACS, VNA, RIS, LIS, and Mirth Connect. Students will also learn to manage imaging data using DICOMweb and cloud platforms, and apply data science and AI methods for imaging analytics, digital pathology, and workflow integration.

Course Outcomes:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Describe the structure, components, and workflows of medical imaging and digital pathology systems.	L2	Understand
CO2	Apply healthcare interoperability standards such as HL7 v2.x, FHIR, and DICOM for accurate and secure data exchange.	L3	Apply
CO3	Design imaging data pipelines using Mirth Connect, PACS, VNA, and cloud-based DICOMweb services.	L6	Create
CO4	Analyze medical imaging and digital pathology datasets using data science and AI techniques, including federated learning workflows.	L4	Analyze

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Medical Imaging Informatics and Inteoperability (RCP23DCPE613) Course Contents

Unit-I 06 Hrs.

Modalities in Medical Imaging:

Overview of medical imaging modalities (Radiology, Cardiology, Pathology): X-ray, XA, mammography, CT, MRI, PET, Ultrasound, Echocardiogram, Whole slide imaging (WSI).

Unit-II 10 Hrs.

Healthcare Interoperability and Data Exchange Standards:

HL7 v2.x messaging: ADT, ORM, ORU, SIU, MDM, DFT, BAR, RDS, RDE, ACK.

Medical Coding & Terminology Standards:

LOINC, SNOMED CT, ICD, CPT, Healthcare API Standards, API Workflow in Healthcare, Challenges in Healthcare API Adoption.

Unit-III 08 Hrs.

DICOM and Imaging Data Standards:

DICOM architecture, DICOM file format, SOP classes, DIMSE operations (C-ECHO, C-STORE, C-FIND, C-MOVE). DICOM association, metadata, IODs. PACS workflow using DICOM DICOM for Digital Pathology (VL Whole Slide Microscopy Image IOD).

Unit-IV 08 Hrs.

DICOMweb & Cloud Imaging:

JSON and REST-based imaging workflows, DICOM web services (WADO-RS, STOW-RS, QIDO-RS). AWS Health Imaging, S3, Sage Maker, IAM – DICOM storage and AI integration. GCP Healthcare API, Vertex AI, Big Query – DICOM web and FHIR interoperability. Azure Health Data Services, Blob Storage, Power BI – secure imaging workflows.

Unit-V 06 Hrs.

Enterprise Imaging Systems:

Imaging workflow and personas: Radiology, cardiology and pathology workflows, PACS, RIS, LIS, VNA, HIS, viewer, WSI scanner PACS and VNA architectures. IHE profiles – SWF, PIR, XDS-I.

Unit-VI 04 Hrs.

AI in Medical Imaging::

Imaging datasets (DICOM, NIFTI, Pathology data), federated learning, MonAI models and in in imaging workflow, Data anonymization.

Medical Imaging Informatics and Inteoperability Laboratory (RCP23DLPE613)

List of Laboratory Experiments

Suggested Experiments (Any 08)

1. Deploy a cloud-hosted PACS using Orthanc on AWS and verify DICOM C-STORE and C FIND operations.
2. Configure DICOM Web endpoints on Azure and perform QIDO-RS, WADO-RS, and STOW RS operations using REST tools.
3. Launch OHIF viewer on GCP and integrate with Orthanc to visualize CT/MRI studies and annotations.
4. Use Google Cloud Healthcare API to create a DICOM datastore, upload studies, run QIDO queries, and export metadata to Big Query.
5. Simulate a Radiology workflow using Mirth Connect by sending HL7 ADT and ORM messages to Orthanc and generating a DICOM worklist.
6. Convert Whole Slide Image (WSI) files to DICOM-VL format, upload to Orthanc, and view multi-resolution tiles in OHIF pathology mode.
7. Implement Federated Learning for medical imaging using Flower/NVFlare and train a shared CNN model without sharing raw data.
8. Train a MONAI-based UNet on MRI tumor segmentation data, export the trained model, and deploy an inference API using FastAPI.
9. Deploy MONAI Label and perform AI-assisted interactive annotation on CT/MRI studies using 3D Slicer or OHIF.
10. Mini Project.

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

Text Books:

1. Tim Benson , Grahame Grieve, "Principles of Health Interoperability: HL7, FHIR, and SNOMED", Springer, 2021.

2. Darren Treanor ,Keith J. Dreyer, "Digital Pathology: Current Practices and Future Directions", Springer, 2021.

3. Barton F. Branstetter, "Practical Imaging Informatics: Foundations and Applications for PACS Professionals", Springer, 2021.

4. H.K. Huang, "PACS and Imaging Informatics: Basic Principles and Applications", Wiley Blackwell, 2010.

5. Oleg S. Pianykh, "Digital Imaging and Communications in Medicine (DICOM): A Practical Introduction and Survival Guide" , Springer, 2012.

Reference Books:

1. HL7 International, HL7 v2.x and FHIR Specifications, Available at: www.hl7.org, 2024.

2. IHE International, IHE Technical Frameworks (Radiology, IT Infrastructure, Pathology), 2024

3. NEMA, DICOM Standard (PS3.1–PS3.20) and Supplement 145: Whole Slide Imaging, National Electrical Manufacturers Association, 2023.

4. Daniel Rueckert et al., Deep Learning in Medical Image Analysis, Academic Press, 2020.

5. Maier, A., Steidl S., Christlein V., Hornegger, J.,"Medical Imaging Systems: An Introductory Guide.", Springer,2018.

6. George C. Kagadis , Steve G. Langer, "Informatics in Medical Imaging", CRC Press, 2011.

Web Links:

1. Health Informatics Specialization: Coursera, offered by Johns Hopkins University
2. Health Informatics on FHIR (edX/Georgia Tech)
3. HL7 FHIR Official Site: https://hl7.org/fhir
4. DICOM Standard: https://dicomstandard.org/
5. IHE Technical Frameworks: https://profiles.ihe.net/
6. NextGen Mirth Connect Documentation: https://docs.nextgen.com/display/mirthconnect
7. NIH Digital Pathology Resources: https://www.pathologyatlas.nih.gov/

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech.	Semester: VI
Ethical Hacking & Digital Forensics (RCP23DCPE614)		
Ethical Hacking & Digital Forensics Laboratory (RCP23DLPE614)		

Prerequisite: Information Security.

Course Objective(s):

1. To understand ethical hacking concepts, hacker classifications, and hacking methodologies.
2. To understand and use basic tools and methods to find information about computer systems through footprinting, scanning, and enumeration.
3. To introduce the phases and tools used in penetration testing and system hacking.
4. To explain the fundamentals and significance of digital forensics in various domains.
5. To develop the ability to collect, preserve, and analyze digital evidence using proper techniques and tools while considering legal and anti-forensic challenges.
6. To familiarize students with modern forensic tools and techniques used in email and mobile device investigations.

Course Outcomes:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain ethical hacking concepts, hacker types, legal aspects, and real-world applications.	L2	Understand
CO2	Use footprinting, scanning, and enumeration tools to gather system and network information.	L3	Apply
CO3	Demonstrate basic system hacking techniques and Perform penetration testing.	L3	Apply
CO4	Apply file system and disk forensics tools and describe digital evidence.	L3	Apply
CO5	Apply evidence collection, hashing, and anti-forensics detection methods.	L3	Apply
CO6	Analyze network traffic, email artifacts, and mobile device data using forensic tools.	L4	Analyze

Ethical Hacking & Digital Forensics (RCP23DCPE614) Course Contents

Unit-I 06 Hrs.

Introduction to Ethical Hacking:

Introduction to Ethical Hacking, Classification of Hackers (White Hat, Black Hat, Grey Hat), Phases of Ethical Hacking, Cybersecurity vs Ethical Hacking, Cyber Laws and Ethical Responsibilities, Introduction to Artificial Intelligence in Cybersecurity and Hacking, Real-World Case Studies of Ethical Hacking .

Unit-II 06 Hrs.

Footprinting, Scanning, and Enumeration:

Footprinting Techniques, DNS Interrogation, Email Harvesting, Social Engineering, Footprinting Tools (Maltego, Recon-ng), Scanning Methodology, Port Scanning Types and Tools (Nmap, Netcat), Enumeration Techniques, Enumeration Tools (SNMP, SMB, LDAP), Banner Grabbing, Use of AI for Automated Reconnaissance and Threat Detection .

Unit-III 08 Hrs.

Penetration Testing and System Hacking:

Penetration Testing: Fundamentals of Penetration Testing, Types of Penetration Testing (Black Box, White Box, Grey Box), Phases of Penetration Testing, Penetration Testing Tools (Metasploit, Burp Suite, Nikto,etc)

System Hacking: Password Attacks (Brute-force, Dictionary, Rainbow Tables), Privilege Escalation Techniques, Malware and Rootkits, Executing Applications and Hiding Files, System Hacking Tools, Introduction to Dark Web and TOR Network, Dark Web-based Threat Intelligence and Anonymity Tools.

Unit-IV 07 Hrs.

Introduction to Digital Forensics:

Definition and Scope of Digital Forensics, Types and Characteristics of Digital Evidence, Phases of a Digital Investigation, File System Forensics (FAT, NTFS), Disk Imaging and Cloning (Bit-by-Bit Copy), Data Recovery Concepts, Deleted File and Slack Space Analysis, Metadata Extraction and Timestamp Interpretation, Disk Forensics Tools (FTK Imager, Autopsy, EnCase), Role of AI and Machine Learning in Digital Forensics.

Unit-V 08 Hrs.

Evidence Collection and Data Analysis:

Evidence Collection Techniques (Live vs Dead), Chain of Custody and Legal Considerations, Volatile and Non-Volatile Evidence Acquisition, Remote Evidence Acquisition, Hashing Algorithms (MD5, SHA1, SHA256) for Verification, Write Blockers and Imaging Devices, Anti-Forensics Techniques (Data Hiding, Steganography, File Obfuscation), Detection and Countering Anti-Forensics, Use of AI Tools for Pattern Detection and Data Anomaly Analysis, Data Carving and Signature-Based Recovery.

Unit-VI 07 Hrs.

Network, Email, and Mobile Forensics:

Network Forensics (Packet Capture, Flow Analysis), Live Traffic Monitoring Tools (Wireshark, TCP-Dump), Log File and Firewall Analysis, Intrusion Detection Logs, Honeynet and Sandbox Environments, Email Forensics (Header and Server Log Analysis, MIME Format), Mobile Device Forensics (Android and iOS), Acquisition Techniques (Logical, Physical, Cloud), SIM and App Data Extraction, Tools (Cellebrite, XRY, MOBILedit), Open Source Intelligence (OSINT) and Threat Attribution Techniques.

Ethical Hacking & Digital Forensics Laboratory (RCP23DLPE614)

List of Laboratory Experiments

Suggested Experiments (Any 08)

1. **Footprinting and Reconnaissance:**
   Objective: Gather information about a target using passive and active footprinting techniques.
   Tools: Recon-ng, theHarvester, SpiderFoot (for AI-powered OSINT), ThreatFox, VirusTotal

2. **DNS Interrogation and Email Harvesting**
   Objective: Perform WHOIS lookups, DNS zone transfers, and identify email addresses.
   Tools: nslookup, dig, whois, theHarvester

3. **Scanning and Enumeration**
   Objective: Identify open ports, services, and perform OS detection.
   Tools: Nmap, Netcat

4. **Enumeration**
   Objective: Extract user and system info via SMB and SNMP protocols.
   Tools: enum4linux, snmpwalk

5. **Web Application Scanning**
   Objective: Scan a web server for vulnerabilities.
   Tools: Nikto, OWASP ZAP, Burp Suite Community Edition

6. **Exploitation Using Metasploit Framework**

   Objective: Exploit vulnerabilities in a virtual test machine.

   Tools: Metasploit Framework, DVWA, Metasploitable VM

7. **Password Cracking**

   Objective: Perform brute-force and dictionary attacks on password hashes and login services.

   Tools: John the Ripper, Hydra, Hashcat

8. **Disk Imaging and Basic Forensic Analysis**

   Objective: Create and analyze a disk image.

   Tools: FTK Imager, Autopsy, dd

9. **File System and Deleted File Analysis**

   Objective: Recover deleted files and analyze file system metadata.

   Tools: Autopsy, Sleuth Kit (fls, icat), Scalpel

10. **Hashing and Data Integrity Verification**

    Objective: Generate and verify file hashes to maintain evidence integrity.

    Tools: md5sum, sha256sum, HashCalc

11. **Network Traffic Capture and Protocol Analysis**

    Objective: Capture and analyze live network traffic for suspicious activity.

    Tools: Wireshark, TCPDump

12. **Email Header Analysis and Evidence Extraction**

    Objective: Trace the source of an email and extract digital evidence.

    Tools: Autopsy (email plugin), ExifTool

13. **Live Memory Acquisition and Analysis (Windows/Linux)**

    Objective: Acquire and examine volatile memory for evidence.

    Tools: WinPmem (Windows), LiME (Linux), Volatility

14. **Steganography and Anti-Forensics Detection**

    Objective: Detect hidden data in images and analyze steganographic files.

    Tools: OpenStego, Steghide, binwalk

15. **Dark Web Exploration & TOR-based Threat Discovery**

    Objective:To explore TOR and Dark Web Securely

    Tools: TOR browser, OnionScan, Ahmia

16. **Mobile Device Forensics and App Data Extraction**

    Objective: TOR browser, OnionScan, Ahmia

    Tools: MOBILedit, ADB, Cellebrite (demo)

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

Text Books:

1. EC-Council, "Ethical Hacking and Countermeasures Attack Phases", Cengage Learning,2nd Edition, 2017.
2. Rafay Boloch, "Ethical Hacking and Penetration Testing Guide", CRC Press, 2014.
3. John R. Vacca, "Computer Forensics", Computer Crime Investigation Firewall Media, New Delhi. 2012
4. Nelson, Phillips, Steuart, "Guide to Computer Forensics and Investigations", CENGAGE Learning, 6th Edition, 2020.
5. E. Casey, "Digital Evidence and Computer Crime: Forensic Science, Computers and the Internet", 3rd edition. Burlington, MA, USA: Academic Press, 2011.
6. S. Davidoff, J. Ham, "Network Forensics: Tracking Hackers through Cyberspace", Upper Saddle River, NJ, USA: Prentice Hall, 2012.

Reference Books:

1. Kevin Smith, "Hacking How to Hack - The ultimate Hacking Guide", Hacking Intelligence,2018.
2. Kevin Beaver, "Ethical Hacking for Dummies", Sixth Edition,Wiley, 2018.
3. Keith J. Jones, Richard Bejtiich, Curtis W. Rose, "Real Digital Forensics", Addison- Wesley Pearson Education 2006
4. Tony Sammes , Brian Jenkinson, "Forensic Compiling", A Tractitioneris Guide, Springer International edition.
5. Christopher L.T. Brown, "Computer Evidence Collection & Presentation", Firewall Media.
6. Jesus Mena, "Homel and Security, Techniques & Technologies", Firewall Media.
7. J. T. Luttgens, M. Pepe, K. Mandia, "Incident Response and Computer Forensics", 3rd edition.

Web Links:

1. Ethical Hacking – IIT Kharagpur (NPTEL) nptel.ac.in/courses/106/105/106105217/
2. Digital Forensics – UTAustin / Prof. Matt L. (Free Online Course) https://digital-forensics.utexas.edu/
3. Introduction to Cybersecurity Tools & Cyber Attacks – IBM (Coursera Free Audit) https://www.coursera.org cybersecurity-tools-cyber-attacks

4. Cybersecurity Fundamentals – University of Washington (edX Free Audit) https://www.edx.org/learn/cyber of-washington-cybersecurity-fundamentals
5. Digital Forensic Techniques – OpenLearn (The Open University) https://www.open.edu/openlearn/science-maths-technology/digital-forensics/content-section-0
6. Network Forensics – University of California, Davis (Coursera Free Audit) https://www.coursera.org/learn/n security
7. Open-Source Intelligence (OSINT) Training – EUROPOL / ENLETS https://osintframework.com/

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Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech.	Semester: VI
Computer Vision (RCP23DCPE621)		
Computer Vision Laboratory (RCP23DLPE621)		

Prerequisite: Machine Learning -I , Machine Learning- II(Deep Learning).

Course Objective(s):

1. To equip students with advanced skills in image, video, and computer vision processing, emphasizing feature extraction, shape and motion analysis, object detection, and action recognition through both classical and deep learning approaches for effective visual understanding and prediction.

Course Outcomes:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply fundamental image and video processing techniques for visual data analysis	L3	Apply
CO2	Analyze object detection and recognition algorithms for visual understanding.	L4	Analyze
CO3	Apply advanced vision models for data analysis and prediction.	L3	Apply

Computer Vision (RCP23DCPE621)
Course Contents

Unit-I — 09 Hrs.

Foundations of Computer Vision and Image Preprocessing:

Basics of image processing. Image acquisition. Preprocessing.Enhancement.Segmentation. Representation. Image transforms: Fourier Transform, Discrete Cosine Transform,Wavelet Transform.

Morphological Image Processing:

Dilation, Erosion, Opening and Closing, Hit-or-Miss Transformation. Morphological Algorithms: Boundary Extraction, Region Filling, Extraction of Connected Components, Thinning, Thickening, Skeletons, Pruning,Morphological Reconstruction. Image Preprocessing Challenges: Clutter, deformation, intra-class variation, Gaussian blur, noise removal, illumination variance, normalization techniques.

Unit-II — 10 Hrs.

Shape Analysis and Segmentation Techniques in Vision:

Contour-Based Methods: Chain Codes, Geometric Border Representation, Fourier Transform of Boundaries, Boundary Description using Segment Sequences, BSpline Representation, Shape Invariants. Region-Based Methods: Scalar Region Descriptors, Moments, Convex Hull, Graph Representation Using Region Skeletons, Region Decomposition, Region Neighborhood Graphs.

Thresholding: Foundation, Role of illumination, Basic Global thresholding, Otsu's method Region Based segmentation: Region Growing, Region Splitting and merging, Relationships between pixels, Hough transform.

Unit-III — 10 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. 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.

Unit-IV — 09 Hrs.

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Generative Models:

Types of generative models: Implicit and Explicit density; Generative Adversarial Network; Vanilla GAN, Mode Collapse in GAN (Strategies to address Mode Collapse and Convergence Issues); Conditional GAN, DC GAN, Wasserstein GAN (WGAN), CycleGAN, StyleGAN; GAN objective functions, JSD Divergence, EM Distance, Least Squares, Evaluation Metrics: Inception Score (IS), Fréchet Inception Distance (FID)

Unit-V 10 Hrs.

Object Segmentation:

Semantic segmentation, Scene Parsing, semantic flow,Bilinear Interpolation, Symmetry in Segmentation, Featured image pyramid,pixel-wise softmax, PSPNet, FPN, UNet, clustering method for segmentation,Distance metrics(Euclidean, Cosine, Hamming, Manhattan, Minkowski,Chebyshev,Jaccard, Haversine), Linkage Types (Single, Average, Complete,Centroid).

Unit-VI 08 Hrs.

Motion Analysis and Optical Flow:

Basics of motion estimation and optical flow using classical and deep learning methods. 3D Vision Components: Stereo Matching, disparity estimation, depth computation.

Action Recognition and Object Tracking: Introduction to recognizing actions and tracking moving objects in videos. Video Processing and Spatio-Temporal Features Overview of video signals, motion models, and basic spatio-temporal analysis.

Computer Vision Laboratory (RCP23DLPE621)

List of Laboratory Experiments

Suggested Experiments (Any 08)

1. To perform morphological operations on Image.
2. To perform image enhancement in frequency domain.
3. To perform segmentation using region growing , merging and splitting.
4. To detect cancer cells using medical image processing techniques through CNN-based object detection.
5. To identify vehicles from road traffic CCTV video footage using the YOLO object detection algorithm.
6. To convert black-and-white images into colored images using GAN.
7. To detect deepfakes in digital media using GAN.
8. To perform image segmentation using advanced deep learning models such as PSPNet, FPN, and UNet.

9. To analyze body postures through motion analysis using spatio-temporal feature extraction techniques.

10. Mini Project.

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. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning" , MIT Press, Reprint Edition with updates, 2022.

2. Shafqat Alauddin, Mrutyunjaya S. Yalawar, S. Bharathidasan, T. Thiyagarajan, "Image Processing Techniques and its Applications in Computer Vision and Artificial Intelligence",2024.

Reference Books:

1. Richard Szeliski, "Computer Vision: Algorithms and Applications ", 2nd Edition, Springer, 2022.

2. Kevin P. Murphy, "Probabilistic Machine Learning: An Introduction" , MIT Press, 2022.

3. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing ", 4th Edition, Pearson Education, 2021.

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/

R. C. Patel Institute of Technology, Shirpur — Autonomous

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech.	Semester: VI
Robotics and AI (RCP23DCPE622)		
Robotics and AI Laboratory (RCP23DLPE622)		

Prerequisite: Linear algebra and Probability theory.

Course Objective(s):

1. To introduce fundamental concepts, kinematics, perception, planning, and control in robotics with an emphasis on data acquisition, machine learning, and autonomous navigation.

Course Outcomes:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Illustrate the fundamental principles, components, and kinematics of robotic systems.	L3	Apply
CO2	Apply sensor data acquisition, preprocessing, and fusion techniques using Python and ROS.	L3	Apply
CO3	Analyze computer vision, path planning, and SLAM algorithms for perception and navigation.	L4	Analyze
CO4	Develop control and decision-making strategies for autonomous robot operation.	L6	Create

Robotics and AI (RCP23DCPE622)
Course Contents

Unit-I 08 Hrs.

Introduction to Robotics:

Evolution of Robotics, Types of robots – industrial, mobile, humanoid, and autonomous, Components of robotic system (sensing, actuation, control, AI), Types of Sensors – IMU, LiDAR, Camera, GPS, Ultrasonic, Proximity Sensors (Infrared), Vision Sensors, Accelerometers, Gyroscopes, and Encoders (Linear or Rotary), Types of Actuators – Electric (DC, Stepper, Servo Motors), Hydraulic, Pneumatic, and Emerging Smart Actuators (Piezoelectric, Shape Memory Alloy, Electroactive Polymer).

Unit-II 12 Hrs.

Robot Kinematics and Motion planning:

Coordinate frames and transformations – homogeneous transformation matrices,Forward and inverse kinematics; Denavit–Hartenberg (D–H) parameters,Differential kinematics and Jacobians – conceptual and numerical examples,Configuration space and robot motion representation, Motion planning – introduction, path and trajectory concepts,Types of trajectory planning – Point-to-Point (PTP) and Continuous Path (CP).

Unit-III 08 Hrs.

Data Acquisition and Preprocessing:

Data collection and preprocessing from multiple sensors through frameworks and middleware (e.g., ROS) for acquisition, synchronization, and refinement of sensor data., Understanding sensor data formats and structures (CSV, JSON, image/video files and ROS bag files). Noise handling using Gaussian, Median, and Kalman filtering methods. Aligning multi-sensor data streams (camera, LiDAR, IMU) using temporal synchronization, spatial calibration, and sensor fusion methods. Handling missing or corrupted data using interpolation, statistical imputation, and smoothing methods, Sensor calibration using intrinsic and extrinsic methods for camera– LiDAR and IMU sensors.

Unit-IV 08 Hrs.

Robot Perception:

Introduction to robot perception and environment understanding, Computer vision in robotics – image acquisition, feature extraction, and object recognition,Application of machine learning and deep learning for perception: Classification using CNN and SVM, Object detection using YOLO and SSD, Image segmentation using U-Net and SegNet, building 3D representations from LiDAR using Voxel Grid Mapping or from stereo vision using SGBM (Semi-Global Block Matching).

Unit-V 12 Hrs.

Path Planning:

Path planning algorithms –Rapidly-exploring Random Tree(RRT), and PRM, Simultaneous Localization and Mapping (SLAM),Components – Localization, mapping, sensor data processing, Types of SLAM – Visual SLAM, LiDAR-based SLAM, RGB-D SLAM, Data association and map building, Learning-based SLAM and navigation using neural implicit mapping and policy learning, Integration of SLAM with path planning and control for autonomous navigation, Evaluation metrics – accuracy, drift, real-time performance, and scalability, Reinforcement Learning for Navigation using Q-Learning, Sim-to-Real Transfer – Domain Randomization, Imitation Learning, Challenges, and Evaluation.

Unit-VI 08 Hrs.

Control and Decision Making:

Control architectures – Open Loop, Closed Loop, and Hierarchical, PID and Feedback Control, Model Predictive Control (MPC) for trajectory tracking,Behavior-Based Robotics – Subsumption Architecture and Reactive Control, Reinforcement Learning for Robot Control – DDPG, PPO, A3C, TRPO, TD3, Human-Robot Interaction – Shared Autonomy, Intent Recognition, and Safety Considerations.

Robotics and AI Laboratory (RCP23DLPE622)

List of Laboratory Experiments

Suggested Experiments (Any 08)

1. Install and explore ROS or Webots; visualize a simple robot model.
2. Simulate a robotic arm and perform forward and inverse kinematics using Python or MATLAB.
3. Acquire and preprocess sensor data (camera or LiDAR dataset) using Python
4. Implement visual feature detection using SIFT or SURF, or deep object recognition using YOLO or MobileNet.
5. Simulate SLAM using ROS or Gazebo datasets
6. Implement EKF-based localization or 2D SLAM using Python
7. Implement a RRT-based path planner in Webots or Gazebo
8. Implement PID control for a mobile robot simulation using Python or Webots.
9. Implement a simple reinforcement learning control policy for navigation or balancing tasks using Python or Webots.
10. Integrate perception, localization, and planning on a simulated robot using TurtleBot or drone simulation.

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. Roland Siegwart, Illah R. Nourbakhsh, and Davide Scaramuzza, "Introduction to Autonomous Mobile Robots", 3rd Edition, MIT Press, 2022.

2. Peter Corke, "Robotics, Vision and Control: Fundamental Algorithms in Python", 3rd Edition,Springer, 2023.

3. Jonathan Cacace, "Ultimate Robotics Programming with ROS 2 and Python", 1st Edition, 2024.

Reference Books:

1. Mohamed M. Atia, "Sensor Fusion Approaches for Positioning, Navigation, and Mapping: How Autonomous Vehicles and Robots Navigate in the Real World with MATLAB Examples", 1st Edition, Springer, 2025.

2. Christoph Bartneck, Tony Belpaeme, Friederike Eyssel, Takayuki Kanda, Merel Keijsers & Selma Šabanović, "Human-Robot Interaction – An Introduction", 2nd Edition, Cambridge University Press, 2024.

3. Larry T. Ross, Stephen W. Fardo Michael F. Walach, "Industrial Robotics Fundamentals", 4th Edition, Jones Bartlett Learning, 2023.

Web Links:

1. https://swayam.gov.in/nc_details/NPTEL (Introduction to Robotics by IIT Madras and Robotics by IIT Kharagpur)

2. https://www.udemy.com/course/robotics-course/

3. https://www.coursera.org/courses?query=robotics

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech.	Semester: VI
Applied Game Theory (RCP23DCPE623)		
Applied Game Theory Laboratory (RCP23DLPE623)		

Prerequisite: Linear Algebra, Calculus, Probability, Statistics and Basic algorithm design and analysis.

Course Objective(s):

1. Introduce fundamental principles of strategic, zero-sum, non-zero-sum, and repeated games with computational simulation.
2. Develop the ability to model, analyse, and solve multi-agent interactions using algorithmic and Python-based approaches.
3. Familiarize students with evolutionary, cooperative, and Bayesian game-theoretic frameworks, including reinforcement learning and human-in-the-loop feedback.
4. Apply game-theoretic reasoning to real-world applications such as auctions, market design, bargaining, and resource allocation.

Course Outcomes:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze and simulate strategic, zero-sum, and non-zero-sum games to identify Nash equilibria and optimal strategies.	L4	Analyze
CO2	Apply algorithmic techniques and reinforcement learning to compute equilibria and model multiagent interactions.	L3	Apply
CO3	Evaluate evolutionary, cooperative, and Bayesian game scenarios for fairness, stability, and decision-making efficiency.	L5	Evaluate
CO4	Design, implement, and assess real-world games and applications, including auctions, repeated games, market design, and RL-based strategy optimization.	L6	Create

Applied Game Theory (RCP23DCPE623)
Course Contents

Unit-I 08 Hrs.

Introduction to Game Theory:

Strategic games, players, strategies, payoffs; dominance, minimax, saddle points; pure & mixed strategy Nash equilibria; real-world examples: auctions, pricing, simple multi-agent interactions

Unit-II 08 Hrs.

Zero-Sum and Non-Zero-Sum Games:

Zero-sum games, saddle points, matrix games; mixed strategies; non-zero-sum games, iterated elimination of dominated strategies; Lemke–Howson algorithm.

Unit-III 10 Hrs.

Evolutionary and Cooperative Game Theory:

Evolutionarily Stable Strategies (ESS), replicator dynamics, fictitious play; cooperative games: transferable utility, core, Shapley value, nucleolus; correlated equilibria; Multi-Agent Reinforcement Learning (MARL) and reward shaping with human feedback.

Unit-IV 10 Hrs.

Bayesian and Algorithmic Game Theory:

Bayesian games, Bayes–Nash equilibrium, auctions, bilateral trading; complexity of equilibrium computation; mechanism design basics; Vickrey auction, incentive compatible resource allocation.

Unit-V 10 Hrs.

Repeated and Extensive Form Games:

Repeated games: Nash Folk Theorem, subgame perfect equilibrium, one-shot deviation principle; extensive form games: game trees, backward induction, sequential equilibria

Unit-VI 10 Hrs.

Game Design, Simulation, and Real-World Applications:

Game design principles: payoff engineering, fairness, multiplayer dynamics; applications: oligopoly models, voting games, matching markets, resource allocation, utility theory; RL-based strategy optimization and human-in-the-loop feedback.

Applied Game Theory Laboratory (RCP23DLPE623)

List of Laboratory Experiments

Suggested Experiments (Any 08)

1. Strategic-Form Games and Payoff Matrix Construction: Construct and simulate matrix games; compute best responses and pure Nash equilibria.
2. Dominance Analysis and Mixed Strategy Nash Equilibria: Analyse dominance relations, compute mixed strategies, and visualize payoffs.
3. Zero-Sum Game Simulation and Minimax / Saddle Points: Implement zero-sum games and compute saddle points using Python.
4. Non-Zero-Sum Game Simulation and Iterated Elimination of Dominated Strategies: Solve nonzero-sum games computationally and identify NE.
5. Lemke–Howson Algorithm Implementation: Compute Nash equilibria of bimatrix games algorithmically.
6. Evolutionarily Stable Strategies (ESS) and Replicator Dynamics: Simulate population dynamics and ESS in multi-agent systems.
7. Fictitious Play and Multi-Agent Reinforcement Learning (MARL): Implement learning strategies for repeated interactions and observe convergence.
8. Cooperative Game Theory: Core, Shapley Value, Nucleolus Computation: Compute fair allocations in transferable utility games.
9. Bayesian Games and Bayes–Nash Equilibrium: Implement games with incomplete information and compute equilibria.
10. Auction Simulation: First-Price, Second-Price, Sealed-Bid, and Online Auctions; Analyse strategy and outcomes.
11. Repeated and Extensive Form Games: Simulate repeated strategies, subgame-perfect equilibrium,and backward induction in game trees.
12. Matching Market and Resource Allocation Applications: Implement market design, matching, and allocation scenarios computationally.
13. Custom Game Design with RL and Human-in-the-Loop Feedback: Design a multi-agent game, implement RL agents, incorporate human feedback, and analyse strategic outcomes.

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

Oral examination will be based on the entire syllabus including, the practicals performed

during laboratory sessions.

Text Books:

1. Game Theory: An Introduction, 3rd Edition by E.N. Barron, Wiley, 2024.
2. Richard S. Sutton and Andrew G. Barto, “Reinforcement Learning: An Introduction”,MIT Press, 2nd Edition, 2022.
3. Binmore, K., Game Theory: A Very Short Introduction, OUP, 2010.

Reference Books:

1. Shoham Y., Leyton-Brown K., ”Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations”, Cambridge University Press, 2024.
2. Thomas Ferguson, ”Game Theory”, World Scientific, 2018.

Web Links:

1. NPTEL Course: https://nptel.ac.in/courses/106105237
2. IIT Bombay: Useful Lecture Notes on Game Theory — IEOR @ IIT Bombay

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech.	Semester: VI
Information Security (RCP23DCPE624)		
Information Security Laboratory (RCP23DLPE624)		

Prerequisite: Computer Communication and Networks

Course Objective(s):

1. To understand the fundamental principles of cryptography, network security, and secure communication mechanisms in modern computer systems.
2. To apply symmetric and asymmetric encryption techniques to ensure confidentiality, authentication, and data integrity.
3. To analyse and evaluate security threats, vulnerabilities, and countermeasures, including the application of machine learning techniques for intelligent threat detection.

Course Outcomes:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the fundamental concepts of cyber-attacks, defence strategies, guiding principles of modern security practices, and apply number theory concepts such as modular arithmetic, Euclid's algorithm, and classical ciphers to illustrate basic cryptographic operations.	L2	Understand
CO2	Apply appropriate encryption, hashing, and authentication protocols to design and implement secure systems and data communication models.	L3	Apply
CO3	Analyze different network threats and attacks such as DDoS, spoofing, and phishing, and evaluate suitable defence mechanisms, including IDS, IPS, and firewalls.	L4	Analyze
CO4	Evaluate the role of machine learning models in cybersecurity, examining their effectiveness in detecting and mitigating cyber threats in real-world scenarios.	L5	Evaluate

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Information Security (RCP23DCPE624)
Course Contents

Unit-I — 10 Hrs.

Introduction:

Cyber Attacks, Defense, Strategies and Techniques, Guiding Principles of Modern Security Practices. OSI security model.

Number Theory: Modulo Arithmetic, Euclid's Algorithm, Fermat's and Euler's Theorem, Chinese Remainder Theorem, Cipher Properties, Substitution Ciphers – Mono-alphabetic Ciphers, Polyalphabetic Ciphers, Transposition Ciphers.

Unit-II — 10 Hrs.

Symmetric Cryptography:

Block Cipher, Fiestel Structure, Block Cipher Modes of Operation, S-DES, Double DES, Triple DES, AES Algorithm.

Asymmetric Cryptography: Private Key and Public Key Cryptography, The RSA algorithm, Key Management, Diffie-Hellman Key Exchange, Key Exchange Algorithm.

Unit-III — 10 Hrs.

Integrity and Authentication:

Cryptographic Hash Functions: Message Authentication, Secure Hash Algorithm(SHA-512),

Message authentication codes: Authentication requirements, HMAC, CMAC, Digital signatures, Elgamal Digital Signature Scheme.

Key Management and Distribution: Symmetric Key Distribution Using Symmetric & Asymmetric Encryption, Distribution of Public Keys, Kerberos, X.509 Authentication Service, Public – Key Infrastructure

Unit-IV — 12 Hrs.

Network Security:

Network attacks, DoS and DDoS attack, Sniffing, Session hijacking, Spoofing, Phishing, Cross-site Scripting (XSS), IPSec Protocol, SSL Handshake Protocol, Firewalls, IDS Prevention and Detection.

Unit-V — 05 Hrs.

Basics of Machine Learning in Cyber Security:

Cyber Threat Landscape, The Cyber Attackers Economy, why use machine learning in cybersecurity?, Real-World Uses of Machine Learning in Security, Spam Fighting: An Iterative Approach, Limitations of Machine Learning in Security.

Unit-VI 09 Hrs.

Machine Learning in Cybersecurity:

Machine Learning: Problems and Approaches, Classification and Clustering, an ML approach for Security, Time Series Analysis and Ensemble Modeling: Analysis of time series in cyber security, Prediction of DDoS attack, Ensemble learning methods and voting ensemble methods to detect cyber attacks.

Information Security Laboratory (RCP23DLPE624)

List of Laboratory Experiments

Suggested Experiments (Any 08)

1. Implement Playfair Cipher with key entered by user.
2. Implement polyalphabetic Cipher
3. Implement Simple and Advanced Columner Transposition technique
4. Implement Simplified DES
5. Implement Simple RSA Algorithm with small numbers.
6. Implement Diffie-Hellman Key Exchange
7. Implement DoS and DDoS attack using Hping.
8. Implement phishing attack using HTTrack Website Cloning.
9. Implement static code analysis using Flawfinder Python Distribution.
10. Implement packet sniffing using Wireshark and TCP Dump.
11. Implement cross site request forgery in a controlled virtual environment using DVWA Web Server.
12. Implement firewalls using IP tables.
13. Implement Network Intrusion Detection System (NIDS).
14. Implement Host based Intrusion Detection System (HIDS).
15. Implementing and Evaluating an Email Spam Classifier Using Naive Bayes or Logistic Regression.
16. Detection of DDoS Attacks in Network Traffic using Random Forest and Ensemble Methods.

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. William Stallings, "Cryptography and Network Security Principles and Practices", Pearson/PHI,8th Edition, 2023.
2. Behrouz A. Forouzan, Debdeep Mukhopadhyay, "Cryptography and Network Security", Mc-GrawHill, 3rd edition 2017.
3. Clarence Chio,David Freeman, "Machine Learning and Security: Protecting Systems with Data and Algorithms", O'REILLY Publications,2018.
4. Soma Halder, Sinan Ozdemir"Hands-On Machine Learning for Cybersecurity", Packt Publishing,2018.

Reference Books:

1. Atul Kahate, "Cryptography and Network Security", McGraw Hill, 3rd Edition, 2013.
2. Bernard Menezes, Network Security and Cryptography, Cengage Learning: 2nd Edition, 2011.
3. Wade Trappe, Lawrence C Washington, "Introduction to Cryptography with coding theory", Pearson: 2nd Edition, 2006.
4. W. Mao, "Modern Cryptography – Theory and Practice", Pearson Education: 1st Edition, 2003.
5. Charles P. Pfleeger, Shari Lawrence Pfleeger – Security in computing – Prentice Hall of India, 2015.

Web Links:

1. Damn Vulnerable Web Application (DVWA): https://dvwa.co.uk/
2. Open Web Application Security Project: https://owasp.org
3. Web penetration testing: https://pentesterlab.com
4. Penetration Testing: https://kali.org

Program: Computer Science & Engineering (Data Science)	T.Y. B.Tech.	Semester: VI
Project Stage-I (RCP23IPEL601)		

Course Objectives:

1. To understand the basic concepts and principles of project development.
2. To formulate/identify the problem statement.
3. To implement the solution as per the problem statement.
4. To develop the team building, writing, logical reasoning and management skills.
5. To provide the connections between the designs and concepts across different disciplinary boundaries.
6. To encourage students to become independent personnel, critical thinkers and lifelong learners.

Course Outcomes:

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

COs	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	Analyze
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:

Domain knowledge (any beyond) needed from the areas of Computer Science & Engineering(Data Science)for the effective implementation of the project. The 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 30% of project stage-I.
- In the second review of this semester, each group is expected to complete 50% of project stage-I.
- Interaction with alumni mentor will also be appreciated for the improvement of project stage-I.

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.
- Assessment of the project (at the end of the semester) will be done by the departmental committee.
- Oral examination shall be conducted by Internal and External examiners. Students have to give presentation and demonstration based on their project stage-I.

Prescribed project report guidelines:

Size of report shall be of minimum 30 pages (excluding cover and front pages). Project stage-I report should include appropriate content for:

- **Abstract**
- **Introduction**
  - Background
  - Motivation
  - Problem Statement
  - Objectives
  - Scope
- **Literature Survey**
  - Review of Existing System(s)

  - Limitations of Existing System(s)

- **Proposed System**
  - Analysis/Framework/ Algorithm
  - Details of H/W and S/W required
  - Design details
  - Methodology (your approach to solve problem)

- **Implementation Plan for Project Stage-II**

- **Conclusion**

- **References**

Assessment criteria for the departmental committee for Continuous Assessment:

Guide will monitor weekly progress and marks allocation will be as per Table 4.

Assessment criteria for the departmental committee for End Semester Exam:

Departmental committee will evaluate project as per Table 5.

Table 4: Log Book Format

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

Table 5: Continuous Assessment Sheet

Sr	P.R.N.	Name of Student	Student Attendance (10)	Log Book Maintenance (10)	Literature Review (10)	Depth of Understanding (10)	Report (10)	Total (50)
			10	10	10	10	10	50

Table 6: Evaluation Sheet

Sr	P.R.N.	Name of Student	Project Stage - I Selection (10)	Design /Methodology /Logic (10)	Fabrication /Modelling /Simulation (10)	Result Verification (10)	Presentation (10)	Total (50)
			10	10	10	10	10	10

Program:Computer Science & Engineering (Data Science)	T.Y. B.Tech.	Semester: VI
Environmental Science Tutorial (RCP23ITHSX06)		

Prerequisite: Interest in Environment and its impact on Human.

Course Objective(s):

1. To familiarise students with environment related issues such as depleting resources, pollution, ecological problems and the renewable energy scenario.
2. To give overview of Green Technology options.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand how human activities affect environment .	L2	Understand
CO2	Understand the various technology options that can make a difference.	L2	Understand

Environmental Science Tutorial (RCP23ITHSX06) Course Contents

Unit-I 02 Hrs.

Air Pollution: Sources of Air pollution. Definition of Air Quality Index and how it is measured.

Unit-II 02 Hrs.

Water Pollution: Sources of water pollution. Ground water pollution and eutrophication.

Unit-III 01 Hrs.

Noise Pollution : Noise pollution and sources. Decibel limits for hospital, library, silence zone.

Unit-IV 01 Hrs.

Biodiversity loss : Value of Biodiversity. Endangered species

Unit-V 02 Hrs.

Deforestation : Product and services provided by forests. Relationship between forests and climate change.

Unit-VI 02 Hrs.

Renewable Energy sources : Our energy needs and global energy crisis. Renewable energy sources.

Unit-VII 02 Hrs.

Climate change: Greenhouse gases and climate change.

Unit-VIII 02 Hrs.

Green Technology : Data Center Energy Efficiency, Thin-Client and Energy Efficiency.

Environmental Science Tutorial (RCP23ITHSX06)

List of Tutorial

1. Case study on Smog.
2. Presentation on Water Pollution (Industrial, Sewage) explaining any specific case
3. List effects of noise pollution on human health. Measure decibel level in college library, canteen, classroom

4. Case study on effect of pollution on Biodiversity loss.
5. Debate for and against to promote Economic Growth Deforestation is required.
6. Presentation on different Renewable Energy Technologies.
7. Report on major impact of Global warming on Environment giving real examples.
8. Report on advantages and examples of Green Building for Sustainable development, Sustainable Software Design.

Text Books:

1. R. Rajagopalan, "Environmental Studies From Crisis to Cure".
2. Erach Bharucha, "Textbook of Environmental Studies For Undergraduate Courses".
3. Narayanan, P., "Environmental Pollution: Principles, Analysis and Control", CBS Publishers Distributors, 2009.
4. Mohammad Dastbaz, Colin Pattinson, Babak Akhgar, Morgan and Kaufman, Elsevier., "Green Information Technology A Sustainable Approach".

Reference Books:

1. Paulina Golinska, Marek Fortsch, Jorge Marx-Gómez, "Information Technologies in Environmental Engineering", New Trends and Challenges, Springer, 2011.

Web Links:

1. CITES: https://cites.org/eng
2. Convention on Biological Diversity: www.biodiv.org
3. Kalpvriksh: www.kalpvriksh.org
4. Water pollution: http://en.wikipedia.org/wiki/Water_polution
5. Ecosan: www.eco-solutions.org

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