

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Name of Department: - Computer Science and Engineering

1.	Subject Code:	TCS346	Course Title:	Python Programming
2.	Contact Hours:	L: 3	T: 0	P: 0
3.	Examination Duration (Hrs):	Theory 3	Practical 0	
4.	Relative Weight:	CIE 25	MSE 25	ESE 50
5.	Credits:	3		
6.	Semester:	3		
7.	Category of Course:	DSC		
8.	Pre-requisite:	Fundamental of Computer & Introduction to Programming (TCS101), Programming for problem solving (TCS201)		
9.	Course Outcome:	After completion of the course, the students will be able to: CO1: Identify and describe the fundamental data types and basic operators used in Python programming. CO2: Explain the purpose and usage of functions in Python, including parameters, return values, and modules. CO3: Apply data structures like lists, tuples, and dictionaries to organize and manipulate data for engineering problems. CO4: Analyze the differences between object-oriented programming concepts like inheritance, polymorphism, and encapsulation, and their impact on program design. CO5: Evaluate the suitability of various libraries like NumPy, Pandas, Matplotlib, and Seaborn for specific tasks related to numerical computing, data analysis, and visualization in engineering applications. CO6: Design and implement Python programs using fundamental concepts, data structures, and libraries to solve basic engineering problems involving data cleaning, analysis, and visualization.		

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1	UNIT 1: Python Basics and Functions and Modules Syntax and Semantic Basics: Data types: strings, integers, floats, Variable assignments and expressions, Basic input/output operations Defining and calling functions: Function parameters and return values- Using built-in modules, Creating and using custom modules, Exception handling basics	10
2	UNIT 2: Data Handling Lists: creation, indexing, slicing, and methods Tuples: usage and when to use Dictionaries: creating, accessing, and manipulating Reading from and writing to files: text and binary files	8
3	UNIT 3: Object-Oriented Programming Introduction to classes and objects, Attributes and methods, Inheritance: extending classes Polymorphism: using a unified interface Encapsulation: private and public members	10
4	UNIT 4: Libraries for AI/ML NumPy: arrays, array operations, indexing, reshaping Pandas: DataFrame operations, indexing, merging, grouping Matplotlib: basic plotting, figures, and axes Seaborn: statistical data visualization	10
5	UNIT 5: Intro to Data Science Data cleaning techniques, Exploratory data analysis (EDA): summary statistics, correlation, Visualization techniques: histograms, scatter plots, box plots	8
	Total	46

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Eric Matthes	Python Crash Course: A Hands-On, Project-Based Introduction to Programming	3 rd Edition	No Starch Press, USA	2023
Mark Lutz	Learning Python	5th Edition	O'Reilly Media, USA	2013
Wes McKinney	Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython	2nd Edition	O'Reilly Media, USA	2017

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Joel Grus	Data Science from Scratch: First Principles with Python	2nd Edition	O'Reilly Media, USA	2019
Al Sweigart	Automate the Boring Stuff with Python: Practical Programming for Total Beginners	2nd Edition	No Starch Press, USA	2019

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
TCS346. 1	Identify and describe the fundamental data types and basic operators used in Python programming	1	2	-	1	-	-	-	-	-	-	-	2	3	2	1	
TCS346. 2	Explain the purpose and usage of functions in Python, including parameters, return values, and modules.	1	-	2	1	-	-	-	-	-	-	-	-	2	1	1	
TCS346. 3	Apply data structures like lists, tuples, and dictionaries to organize and manipulate data for engineering problems.	-	-	3	-	-	-	-	-	-	-	-	-	3	1	1	
TCS346. 4	Analyze the differences between object-oriented programming concepts like inheritance, polymorphism, and encapsulation, and their impact on program design.	-	3	-	-	-	-	-	-	-	-	-	2	3	2	1	
TCS346. 5	Evaluate the suitability of various libraries like NumPy, Pandas, Matplotlib, and Seaborn for specific tasks related to numerical computing, data analysis, and visualization in engineering applications.	3	-	-	-	2	-	-	-	-	-	-	-	2	2	1	
TCS346. 6	Design and implement Python programs using fundamental concepts, data structures, and libraries to solve basic engineering problems involving data cleaning, analysis, and visualization.	3	-	2	3	3	-	-	-	-	-	-	-	3	3	2	
TCS346		2	2.5	2.33	1.66	2.5	-	-	-	-	-	-	-	2.33	2.66	1.66	1.16

High correlation (3); Medium correlation (2); Low correlation (1), No correlation (-)

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Name of Department: - Computer Science and Engineering

1.	Subject Code:	TCS364	Course Title:	Fundamentals of Artificial Intelligence and Machine Learning
2.	Contact Hours:	L: 3	T: 0	P: 0
3.	Examination Duration (Hrs):	Theory 3	Practical 0	
4.	Relative Weight:	CIE 25	MSE 25	ESE 50
5.	Credits:	3		
6.	Semester:	III		
7.	Category of Course:	DSC		
8.	Pre-requisite:	Fundamental of Computer & Introduction to Programming (TCS101)		
9.	Course Outcome:	<p>After completion of the course, the students will be able to:</p> <p>CO1: Define Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning, and differentiate between them.</p> <p>CO2: Explain problem-solving frameworks in AI and describe search strategies like breadth-first, depth-first, and A*.</p> <p>CO3: Choose appropriate classification techniques like Logistic Regression, KNN, or SVM based on specific data characteristics.</p> <p>CO4: Compare and contrast different performance metrics like accuracy, precision, recall, and F1-score for evaluating ML models.</p> <p>CO5: Evaluate the strengths and limitations of specific unsupervised learning techniques like K-means and hierarchical clustering for a given task.</p> <p>CO6: Design a simple machine learning pipeline involving data pre-processing, model selection, and evaluation for a classification task.</p>		

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1	<p>UNIT 1: Overview of AI and Intelligent Agents Definition and history of AI, Differences between AI, ML, and deep learning, Applications and impact of AI in various sectors, Agents and environments, Types of agents (simple reflex, model-based, goal-based, utility-based), Agent architecture and environments</p> <p>Problem Solving: Problem-solving frameworks, Search strategies: breadth-first, depth-first, A* Heuristics: designing and applying heuristics</p>	9
2	<p>UNIT 2: Knowledge and Reasoning Knowledge-based AI, Logic and Reasoning: propositional and predicate logic, Inference in first-order logic, Building knowledge bases.</p> <p>Uncertainty Handling: Probabilities and Bayesian networks, Decision making: Expected utility- Markov decision processes</p>	9
3	<p>UNIT 3: Introduction to ML and Data Preprocessing What is Machine Learning? Types of Machine Learning: Supervised, Unsupervised, Reinforcement- ML in practice: Applications and case studies, Importance of data preprocessing, Data cleaning, normalization, and transformation, Feature selection, and dimensionality reduction.</p> <p>Regression Analysis Linear regression, Polynomial regression, Regularization methods: Ridge, Lasso</p>	10
4	<p>UNIT 4: Classification Techniques Logistic regression, K-nearest neighbors (KNN), Support vector machines (SVM)</p> <p>Decision Trees and Random Forests Building decision trees, Overfitting and pruning, Ensemble methods: Random Forests and boosting</p>	10
5	<p>UNIT 5: Evaluation of ML Models and Clustering and Association Training and testing data splits, Performance metrics: accuracy, precision, recall, F1-score, Confusion matrix and ROC curves</p> <p>K-means clustering, Hierarchical clustering, Apriori algorithm for association rule learning</p>	10
	Total	48

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Stuart Russell and Peter Norvig	Artificial Intelligence: A Modern Approach	4th Edition	Pearson Education Limited, USA	2024
Melanie Mitchell	Introduction to Artificial Intelligence	2nd Edition	McGraw-Hill Education, USA	2024
Tom M. Mitchell,	Machine Learning	1st Edition	Mc Graw Hill Publisher	2017
Manaranjan Pradhan, U Dinesh Kumar	Machine Learning using Python	1 st Edition	Wiley, India	2017

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Richard E. Neapolitan and Kevin Goda	Artificial Intelligence: Foundations and Applications	4th Edition	Elsevier Science & Technology, Netherlands	2024
Aurélien Géron	Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow	2nd Edition	O'Reilly Media, Inc., USA	2024
E. Alpaydin,	Introduction to Machine Learning	3 rd Edition	PHI Publisher	2015

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
TCS364.1	Define Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning, and differentiate between them	1	2	-	-	-	-	-	-	-	-	-	2	2	1	1
TCS364.2	Explain problem-solving frameworks in AI and describe search strategies like breadth-first, depth-first, and A*	-	2	-	-	-	-	-	-	-	-	-	1	2	2	1
TCS364.3	Choose appropriate classification techniques like Logistic Regression, KNN, or SVM based on specific data characteristics	2	-	-	2	-	-	-	-	-	-	-	2	2	2	1
TCS364.4	Compare and contrast different performance metrics like accuracy, precision, recall, and F1-score for evaluating ML models	-	-	-	2	-	-	-	-	-	-	-	1	3	1	1
TCS364.5	Evaluate the strengths and limitations of specific unsupervised learning techniques like K-means and hierarchical clustering for a given task	1	2	-	-	-	-	-	-	-	-	-	1	3	1	1
TCS364.6	Design a simple machine learning pipeline involving data pre-processing, model selection, and evaluation for a classification task	-	-	3	-	-	-	-	-	-	-	-	2	3	2	1
TCS364		1.33	2	3	2	-	-	-	-	-	-	-	1.5	2.5	1.5	1

High correlation (3); Medium correlation (2); Low correlation (1), No correlation (-)

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Name of Department: - Computer Science and Engineering

1.	Subject Code:	TCS464	Course Title:	Deep Learning
2.	Contact Hours:	L: 3	T: 0	P: 0
3.	Examination Duration (Hrs):	Theory 3	Practical 0	
4.	Relative Weight:	CIE 25	MSE 25	ESE 50
5.	Credits:	3		
6.	Semester:	IV		
7.	Category of Course:	DSC		

8. Pre-requisite: Fundamentals of Artificial Intelligence and Machine Learning (TCS364), Python Programming (TCS346)

9. Course Outcome:	After completion of the course, the students will be able to: CO1: Define the fundamental concepts of artificial neural networks and differentiate between perceptrons and deep neural networks. CO2: Describe the architecture and functionalities of Convolutional Neural Networks (CNNs) for image processing tasks. CO3: Implement basic neural network architectures using popular deep learning libraries. CO4: Analyze the impact of different activation functions on the performance of neural networks. CO5: Choose suitable deep learning architectures (CNNs, RNNs) based on the specific problem and data characteristics. CO6: Design and implement a deep learning model (e.g., CNN or LSTM) to solve a simple engineering-related problem
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10. Details of the Course:

Sl. No.	Contents	Contact Hours
1	UNIT 1: Introduction to Neural Networks and Deep Neural Networks Basics of neural networks, Perceptrons and activation functions, Architecture of a simple neural network Multi-layer perceptrons (MLP), Forward propagation and backpropagation, Loss functions and optimization algorithms	10

2	UNIT 2: Convolutional Neural Networks (CNNs) Understanding convolutions and pooling, Architecture of CNNs, Applications in image recognition and processing	10
3	UNIT 3: Recurrent Neural Networks (RNNs) and LSTMs Basics of RNNs, Problems with RNNs (vanishing and exploding gradients), Long Short-Term Memory (LSTM) networks	10
4	UNIT 4: Advanced Topics in Deep Learning Autoencoders, Generative Adversarial Networks (GANs), Transfer learning and fine-tuning	10
5	UNIT 5: Practical Applications of Deep Learning Natural Language Processing (NLP), Autonomous vehicles, Medical image analysis	8
Total		48

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
John D. Kelleher	Deep Learning	1 st Edition	MIT Press, USA	2019
Francois Chollet	Deep Learning with Python	2nd Edition	Manning Publications Co., USA	2024
Amlan Chakrabarti Amit Kumar Das, Saptarsi Goswami, Pabitra Mitra	Deep Learning	1 st Edition	Pearson, India	2021

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Maxime Chevalier-Boisvert, Julien Rougerie, and Fabian-Robert Picard	Recurrent Neural Networks for Beginners	1st Edition	Packt Publishing Ltd, UK	2021
Aurélien Géron	Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow	2nd Edition	O'Reilly Media, Inc., USA	2024

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
TCS464.1	Define the fundamental concepts of artificial neural networks and differentiate between perceptrons and deep neural networks	1	2	-	-	-	-	-	-	-	-	-	2	2	1	1
TCS464.2	Describe the architecture and functionalities of Convolutional Neural Networks (CNNs) for image processing tasks	-	-	-	3	-	-	-	-	-	-	-	2	3	1	1
TCS464.3	Implement basic neural network architectures using popular deep learning libraries	-	-	-	3	3	-	-	-	-	-	-	3	3	2	1
TCS464.4	Analyze the impact of different activation functions on the performance of neural networks	-	3	-	2	-	-	-	-	-	-	-	2	3	2	1
TCS464.5	Choose suitable deep learning architectures (CNNs, RNNs) based on the specific problem and data characteristics	2	-	-	2	-	-	-	-	-	-	--	2	2	2	1
TCS464.6	Design and implement a deep learning model (e.g., CNN or LSTM) to solve a simple engineering-related problem	-	-	3	3	-	-	-	-	-	-	-	3	3	2	1
TCS 464		1.5	2.5	3	2.6	3	-	-	-	-	-	-	2.33	2.66	1.66	1

High correlation (3); Medium correlation (2); Low correlation (1), No correlation (-)

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER IV

Name of Department: - Computer Science and Engineering

1.	Subject Code:	TCS445	Course Title:	Responsible and Explainable AI (AI Ethics, Bias and Expandability)		
2.	Contact Hours:	L: 3	T: 0	P: 0		
3.	Examination Duration (Hrs):	Theory 3	Practical 0			
4.	Relative Weight:	CIE 25	MSE 25	ESE 50		
5.	Credits:	3				
6.	Semester:	IV				
7.	Category of Course:	DSE				
8.	Pre-requisite:	Fundamentals of Artificial Intelligence and Machine Learning (TCS364)				

9. Course Outcome:	After completion of the course, the students will be able to: CO1: Identify fundamental ethical principles for developing and deploying AI systems. CO2: Explain the importance of responsible and ethical AI development and its impact on society. CO3: Apply techniques for detecting and measuring bias in AI models relevant to engineering applications. CO4: Critically evaluate the strengths and limitations of different XAI techniques. CO5: Assess the potential benefits and drawbacks of using XAI in different domains like finance, healthcare, and autonomous systems. CO6: Design a framework for incorporating ethical considerations throughout the AI development lifecycle in an engineering project.
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10. Details of the Course:

Sl. No.	Contents	Contact Hours
1	UNIT:1 Introduction to AI Ethics, Bias in AI Systems, Fairness in AI Fundamentals of ethics in AI, Importance of ethical AI development, Overview of common ethical dilemmas in AI, Types of biases in AI (data, algorithmic, interactional), Detecting and measuring bias, Mitigation	10

	strategies for reducing bias, Defining fairness in AI contexts, Fairness metrics and their trade-offs- Designing fair AI systems	
2	UNIT: 2 Transparency and Accountability, AI in Surveillance and Privacy Importance of transparency in AI, Tools and methods for achieving transparency, Accountability frameworks and regulatory compliance, AI applications in surveillance technologies, Privacy concerns and data protection laws, Balancing security and privacy in AI implementations	10
3	UNIT: 3 Societal Impacts of AI AI's impact on employment and economy, AI in governance and public policy, Long-term implications of AI on society	8
4	UNIT4: Introduction to XAI, Local Explanation Methods, Global Explanation Methods Importance of explainability in AI, Overview of XAI methods, Regulatory and ethical considerations, LIME (Local Interpretable Model-agnostic Explanations), SHAP (SHapley Additive exPlanations), Feature importance and perturbation analysis, Decision trees as explanatory models- Rule-based explanations- Global surrogate models	10
5	UNIT:5 Visualization Techniques, Practical Applications of XAI Visualization of feature effects and model decisions, Use of heatmaps and partial dependence plots- Network and layer activation visualizations in deep models XAI in finance (credit scoring, fraud detection), XAI in healthcare (diagnostic systems, treatment recommendations), XAI in autonomous systems (vehicle control systems, robotics)	10
	Total	48

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Stuart Russell, Peter Norvig	Artificial Intelligence: A Modern Approach	3rd Edition	Pearson, USA	2009
Michael Munn, David Pitman	Explainable AI for Practitioners: Designing and Implementing	1st Edition	O'Reilly, India	2022

	Explainable ML Solutions			
John Danaher	Ethics of Artificial Intelligence	2nd Edition	Oxford University Press, USA	2022

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Denis Rothman	Hands-On Explainable AI (XAI) with Python	1 st Edition	Packt Publishing, USA	2020
James Manyika, Michael Chui, and Michael Osborne	The Ethics of Artificial Intelligence	1 st Edition	McKinsey Global Institute, USA	2018

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
TCS445.1	Identify fundamental ethical principles for developing and deploying AI systems	-	2	2	2	-	-	-	-	-	-	-	1	2	2	1
TCS445.2	Explain the importance of responsible and ethical AI development and its impact on society	2	-	2	-	-	-	-	-	-	-	-	2	2	1	1
TCS445.3	Apply techniques for detecting and measuring bias in AI models relevant to engineering applications	-	-	3	-	-	-	-	-	-	-	-	2	3	2	1
TCS445.4	Critically evaluate the strengths and limitations of different XAI techniques	2	-	-	3	-	-	-	-	-	--	--	1	3	2	2
TCS445.5	Assess the potential benefits and drawbacks of using XAI in different domains like finance, healthcare, and autonomous systems	-	2	-	2	-	2	-	-	-	-	3	1	2	1	1
TCS445.6	Design a framework for incorporating ethical considerations throughout the AI development lifecycle in an engineering project	1	1	3	-	3	-	-	3	-	-	-	3	3	2	2
TCS 445		1.66	1.66	2.5	2.33	3	2	-	3	-	-	3	1.66	2.5	1.66	1.33

High correlation (3); Medium correlation (2); Low correlation (1), No correlation (-)

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Name of Department: - Computer Science and Engineering

1.	Subject Code:	TCS484	Course Title:	Biometric Securities
2.	Contact Hours:	L: 3	T: 1	P: 0
3.	Examination Duration (Hrs):	Theory 4	Practical 0	
4.	Relative Weight:	CIE 25	MSE 25	ESE 50
5.	Credits:	3		
6.	Semester:	3		
7.	Category of Course:	DSE		
8.	Pre-requisite:	Mathematical Foundations for Artificial Intelligence (TCS343)		

9. Course Outcome:	After completion of the course the students will be able to: CO1: Basic information on the fundamental physical and organic science. CO2: Understand designing standards of biometric frameworks. CO3: Understand biometric frameworks and be able to examine and design for essential biometric framework applications. CO4: Understand various Biometric security issues. CO5: Describe Cryptography security CO6: Understanding of Fuzzy model
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10. Details of the Course:

Sl. No.	Contents	Contact Hours
1	Unit 1: Introduction- Authentication systems, Development of biometric authentication. Basic terms, biometric data, biometric characteristics, biometric features, biometric templates and references. Expected properties of biometric identifiers. Basics in biometric errors estimation. Enrolment, verification and identification. Applications of Biometrics.	09

2	Unit 2: Fingerprints and Hand Geometry: Technical description, Characteristics, Competing technologies, Strengths–Weaknesses, Deployment. Face and Voice Recognition: Technical description, Characteristics, Strengths-Weaknesses, Deployment.	09
3	Unit 3: Biometric System Security: Secure transfer of biometric data. Secure storage, use of smart cards, principles of match-off-card and match-on-card techniques. Biometrics in the cloud. Points of attack. Privacy models. Spoofing: Static and dynamic liveness features. Liveness detection in biometrics. Selected liveness detection techniques, frequency analysis for paper printouts detection.	10
4	Unit 4: Protection: Overview of principles from cryptography to secure fuzzy data. Template protection strategies: feature protection, key-binding, key-generating, hybrids.	08
5	Unit 5: Overview of fuzzy vaults, fuzzy commitment, fuzzy extractors and revocable bio tokens. Bio cryptographic infrastructures for secure template management.	08
Total		44

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Jiankun Hu, David Chek Ling Ngo, Andrew Beng Jin Teoh	Biometric Security	3 rd Edition	Cambridge Scholars Publishing, USA	2015
Khalid Saeed, Jerzy Pejas, Romuald Mosdorf	Khalid Saeed, Jerzy Pejas, Romuald Mosdorf	5th Edition	Springer Publisher, German	2010
John D. Woodward, Jr.	Biometrics	2nd Edition	dream tech, USA	2003

Nicholas M. Orlans Peter T. Higgins				
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Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
John Chirillo and Scott Blaul	Implementing Biometric Security	2nd Edition	Wiley Eastern Publications, India	2005

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
TCS484.1	Basic information on the fundamental physical and organic science.	1	-	-	-	-	-	-	-	-	-	-	1	1	1	1
TCS484.2	Understand designing standards of biometric frameworks.	-	2	-	-	2	-	-	-	-	-	-	1	2	1	1
TCS484.3	Understand biometric frameworks and be able to examine and design for essential biometric framework applications.	-	2	-	-	2	-	-	-	-	-	-	1	2	1	1
TCS484.4	Understand various Biometric security issues.	-	2	-	-	-	-	-	-	-	-	-	1	2	1	1
TCS484.5	Describe Cryptography security	-	-	-	2	-	-	-	-	-	-	-	2	2	1	1
TCS484.6	Understanding of Fuzzy model	-	2	-	-	-	-	-	-	-	-	-	1	2	1	1
TCS484		1	2	-	2	2	-	-	-	-	-	-	1.16	1.83	1	1

High correlation (3); Medium correlation (2); Low correlation (1), No correlation (-)

2023-24 and 2024-25 onwards

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering		Natural Language Processing and Computer Vision	
1.	Subject Code: TCS564	Course Title:	
2.	Contact Hours: L: 3	T: 0	P: 0
3.	Examination Duration (Hrs): Theory 3	Practical 0	
4.	Relative Weight: CIE 25 MSE 25		ESE 50
5.	Credits: 3		
6.	Semester: V		
7.	Category of Course: DSC		
8.	Pre-requisite: Fundamentals of Artificial Intelligence and Machine Learning (TCS364)		

9. Course Outcome:	After completion of the course, the students will be able to: CO1: Define Natural Language Processing (NLP) and Computer Vision (CV) and their significance in various applications. CO2: Describe the concepts of part-of-speech tagging, syntactic parsing, and n-gram language models used in NLP CO3: Apply basic image manipulation techniques (e.g., filtering, transformations) and color space conversions in computer vision. CO4: Analyze the trade-offs between different object detection frameworks like R-CNN and YOLO. CO5: Evaluate the performance of different object detection models based on metrics like accuracy and precision-recall. CO6: Design a simple NLP pipeline for sentiment analysis or text classification using pre-existing techniques and tools.
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10. Details of the Course:

Sl. No.	Contents	Contact Hours
1	UNIT 1: Introduction to NLP, Text Processing Overview of NLP and its significance, Key challenges in NLP, Common NLP tasks and applications Text normalization: tokenization, stemming, lemmatization, Regular expressions for pattern matching, Stop words removal and text cleaning	9

2	<p>UNIT 2: Syntax and Parsing, Language Models</p> <p>Part-of-speech tagging, Syntactic parsing, Dependency parsing, Introduction to n-grams, Smoothing techniques, Introduction to neural language models</p> <p>Feature Extraction from Text</p> <p>Bag of words and TF-IDF, Word embeddings: Word2Vec, GloVe- Contextual embeddings from transformers</p>	10
3	<p>UNIT 3: Sentiment Analysis</p> <p>Techniques for sentiment analysis, Rule-based and machine learning approaches, Application of sentiment analysis in business and social media</p> <p>NLP Applications</p> <p>Machine translation, Speech recognition, Chatbots and conversational agents</p>	9
4	<p>UNIT 4: Introduction to Computer Vision, Image Processing Basics</p> <p>Overview of computer vision and its significance, Key challenges in computer vision, Common applications of computer vision</p> <p>Digital image fundamentals, Image manipulation techniques (filtering, transformations), Color spaces and conversions</p> <p>Feature Detection and Matching, Image Segmentation</p> <p>Edge detection algorithms, Corner and interest point detection, Feature matching and object recognition, Thresholding techniques, Region-based segmentation, Clustering methods in segmentation (k-means, mean shift)</p>	10
5	<p>UNIT 5: Object Detection and Recognition</p> <p>Introduction to object detection frameworks, Haar cascades and HOG features, Modern approaches: R-CNN, Fast R-CNN, YOLO, and SSD</p> <p>Deep Learning for Vision</p> <p>Convolutional neural networks (CNNs) for vision, Transfer learning in vision tasks, Applications in real-time video processing</p> <p>Advanced Topics and Applications</p> <p>3D vision and depth estimation, Motion analysis and object tracking, Computer vision in autonomous vehicles and drones</p>	10
	Total	48

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Steven Bird, Ewan Klein, and Edward Loper	Natural Language Processing with Python	3rd Edition	O'Reilly Media, Inc., USA	2021
Daniel Jurafsky and James H. Martin	Speech and Language Processing	3rd Edition	Pearson Education Limited, USA	2020
Richard Szeliski	Computer Vision: Algorithms and Applications	2nd Edition	Springer Science, New York, USA	2011
Joseph Howse, Joe Minichino, and Prateek Joshi	Learning OpenCV 4: Computer Vision with Python 3	1st Edition	Packt Publishing Ltd, UK	2019

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Hobson Lane, Cole Howard, and Hannes Hapke	Natural Language Processing in Action	1 st Edition	Manning Publications Co., USA	2019
Yoav Goldberg	Deep Learning for Natural Language Processing	1st Edition	MIT Press, USA	2017
Phil Kim	Deep Learning for Computer Vision	1st Edition	Apress, USA	2017
Richard Hartley and Andrew Zisserman	Computer Vision: Principles, Algorithms, Applications, Learning	5th Edition	Cambridge University Press, UK	2012

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
TCS564.1	Define Natural Language Processing (NLP) and Computer Vision (CV) and their significance in various applications	1	2	-	-	-	-	-	-	-	-	-	2	2	1	1
TCS564.2	Describe the concepts of part-of-speech tagging, syntactic parsing, and n-gram language models used in NLP	-	-	-	3	-	-	-	-	-	-	-	2	3	1	1
TCS564.3	Apply basic image manipulation techniques (e.g., filtering, transformations) and color space conversions in computer vision	-	-	3	-	-	-	-	-	-	-	-	2	3	2	1
TCS564.4	Analyze the trade-offs between different object detection frameworks like R-CNN and YOLO	1	3	-	-	-	-	-	-	-	-	-	2	3	2	1
TCS564.5	Evaluate the performance of different object detection models based on metrics like accuracy and precision-recall	2	-	-	2	-	2	-	-	-	-	-	1	2	1	1
TCS564.6	Design a simple NLP pipeline for sentiment analysis or text classification using pre-existing techniques and tools	-	-	3	-	3	-	-	-	-	-	-	2	3	2	2
TCS564		1.33	2.5	3	2.5	3	2	-	-	-	-	-	1.83	2.66	1.5	1.16

High correlation (3); Medium correlation (2); Low correlation (1), No correlation (-)

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V (ELECTIVE)

Name of Department: - Computer Science and Engineering

1.	Subject Code:	TCS545	Course Title:	Reinforcement Learning				
2.	Contact Hours:	L: 3	T: 1	P: 0				
3.	Examination Duration (Hrs):	Theory 3	Practical 0					
4.	Relative Weight:	CIE 25	MSE 25	ESE 50				
5.	Credits:	3						
6.	Semester:	V						
7.	Category of Course:	DSE						
8.	Pre-requisite:	Fundamentals of Artificial Intelligence and Machine Learning (TCS364)						

9. Course Outcome:	After completion of the course, the students will be able to: CO1: Define fundamental concepts in reinforcement learning, such as agents, environments, states, actions, rewards, and policies. CO2: Explain the core principles of Markov Decision Processes (MDPs) and their use in reinforcement learning. CO3: Apply dynamic programming algorithms (policy iteration and value iteration) to solve simple MDPs relevant to engineering problems. CO4: Compare and contrast TD learning algorithms (SARSA, Q-learning) based on their suitability for specific scenarios. CO5: Evaluate the performance of RL agents using appropriate metrics relevant to the engineering domain. CO6: Design and implement a simple RL agent using techniques like Q-learning or policy gradients to solve a basic engineering-related problem.
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10. Details of the Course:

Sl. No.	Contents	Contact Hours
1	UNIT 1: Introduction to Reinforcement Learning, Markov Decision Processes Overview of reinforcement learning and its applications, Key concepts: agents, environments, states, actions, rewards, Basics of Markov	10

	decision processes (MDPs), Policy and value functions, Bellman equations	
2	UNIT 2: Dynamic Programming, Monte Carlo Methods Policy iteration, Value iteration, Applying dynamic programming to MDPs, Monte Carlo simulation for estimating value functions, On-policy and off-policy learning, Importance sampling	10
3	UNIT 3: Temporal Difference Learning TD learning, SARSA (State-Action-Reward-State-Action), Q-learning	8
4	UNIT 4: Advanced RL Algorithms Deep Q-Networks (DQN), Policy gradient methods, Actor-critic methods	9
5	UNIT 5: RL in Practice Applications in games (e.g., AlphaGo), RL for robotics, Challenges in real-world RL applications	8
	Total	45

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Richard S. Sutton and Andrew G. Barto	Reinforcement Learning: An Introduction	2nd Edition	MIT Press, USA	2018
Maxim Lapan	Hands-On Reinforcement Learning with Python	1st Edition	Packt Publishing Ltd, UK	2020

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Maxim Lapan	Deep Reinforcement Learning Hands-On	1st Edition	Packt Publishing Ltd, UK	2020

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
TCS545.1	Define fundamental concepts in reinforcement learning, such as agents, environments, states, actions, rewards, and policies	1	2	-	-	-	-	-	-	-	-	-	2	2	1	1
TCS545.2	Explain the core principles of Markov Decision Processes (MDPs) and their use in reinforcement learning	1	-	2	1	-	-	-	-	-	-	-	2	2	1	1
TCS545.3	Apply dynamic programming algorithms (policy iteration and value iteration) to solve simple MDPs relevant to engineering problems	-	-	3	-	-	-	-	-	-	-	-	3	3	2	1
TCS545.4	Compare and contrast TD learning algorithms (SARSA, Q-learning) based on their suitability for specific scenarios	-	2	-	2	-	-	-	-	-	-	-	1	1	1	1
TCS545.5	Evaluate the performance of RL agents using appropriate metrics relevant to the engineering domain	-	-	1	2	-	-	-	-	-	-	-	2	2	1	1
TCS545.6	Design and implement a simple RL agent using techniques like Q-learning or policy gradients to solve a basic engineering-related problem	-	-	3	3	-	-	-	-	-	-	-	3	3	2	2
TCS 545		1	2	2.25	2	-	-	-	-	-	-	-	2.16	2.16	1.33	1.16

High correlation (3); Medium correlation (2); Low correlation (1), No correlation (-)

2023-24 and 2024-25 onwards

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1.	Subject Code:	TCS543	Course Title:	Knowledge Representation
2.	Contact Hours:	L: 3	T: 1	P: 0
3.	Examination Duration (Hrs):	Theory 3	Practical 0	
4.	Relative Weight:	CIE 25	MSE 25	ESE 50
5.	Credits:	3		
6.	Semester:	VI		
7.	Category of Course:	DSE		
8.	Pre-requisite:	TCS 409, Design Analysis and Algorithm, TCS 343 Mathematical Foundations for Artificial Intelligence		
9. Course Outcome:	<p>After completion of the course the students will be able to:</p> <p>CO1: Use logic programming and knowledge representation languages for modelling simple application domains in Artificial Intelligence</p> <p>CO2: Apply reasoning mechanisms in knowledge representation languages to test the correctness of models and to formulate more expressive queries.</p> <p>CO3: Design ontology-based knowledge systems with reasoning mechanism; integrate with other systems for building applications.</p> <p>CO4: Understand the entire process of how to design, construct, and query a knowledge graph to solve real-world problems.</p>			

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1	Principles of knowledge representation, Propositional Logic- Proof Systems, Natural Deduction, Tableau Method, Resolution Method. First Order Logic Syntax and Semantics, Unification, Forward Chaining, Horn Fragments of First Order Logic.	10
2	Rule based systems, The Rete Algorithm, Rete example, Programming rule Based Systems, Description Logics, Reasoning in Description Logics, Structure Matching, Classification, Extensions of DL	9
3	The ALC Language, Ontology Representation languages, Ontology Languages- RDF, RDFS-Rule Interchange Format, Logic programming with OWL: OWL-Building OWL ontology- SPARQL- RDF/OWL ontology processing using Graph databases	9
4	Non monotonic logics 4 hours Classical vs non-monotonic logic. Ways to achieve non-monotonicity-Stable Model Semantics querying Semantic Nets and Frames.	8
5	Discussions on Contemporary Issues in knowledge representation	6
	Total	42

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Franz Baader, Ian Horrocks, Carsten Lutz, Uli Sattler	An Introduction to Description Logic	1 st Edition	Cambridge University Press	2017
Ronald Brachman & Hector Levesque	Knowledge Representation and Reasoning	1 st Edition	Morgan Kaufmann, UK	2004
Frank van Harmelen, Vladimir Lifschitz and Bruce Porter (Eds)	Handbook of Knowledge Representation Foundations of Artificial Intelligence	1 st Edition	O'Reilly Media, USA	2008
Ian Robinson, Jim Webber, Emil Eifrem	Graph Databases	2 nd	O'Reilly Media, USA	2015

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Pascal Hitzler, Markus Kroetsch, and Sebastian Rudolph	Foundations of Semantic Web Technologies	1st Edition	CRC Press, United States	2009

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
TCS543.1	Use logic programming and knowledge representation languages for modelling simple application domains in Artificial Intelligence	-	-	2	-	-	-	-	-	-	-	-	1	1	1	1
TCS543.2	Apply reasoning mechanisms in knowledge representation languages to test the correctness of models and to formulate more expressive queries.	1	-	3	-	-	-	-	-	-	-	-	2	3	2	1
TCS543.3	Design ontology-based knowledge systems with reasoning mechanism; integrate with other systems for building applications.	-	-	3	-	-	-	-	-	-	-	-	3	3	2	1
TCS543.4	Understand the entire process of how to design, construct, and query a knowledge graph to solve real-world problems.	-	2	-	2	-	-	-	-	-	-	-	2	2	1	1
TCS543.5																
TCS543.6																
TCS543		1	2	2.66	2	-	-	-	-	-	-	-	2	2.25	1.5	1

High correlation (3); Medium correlation (2); Low correlation (1), No correlation (-)

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1.	Subject Code:	TCS665	Course Title:	Generative Adversarial Networks
2.	Contact Hours:	L: 3	T: 0	P: 0
3.	Examination Duration (Hrs):	Theory 3	Practical 0	
4.	Relative Weight:	CIE 25	MSE 25	ESE 50
5.	Credits:	3		
6.	Semester:	VI		
7.	Category of Course:	DSC		
8.	Pre-requisite:	Fundamentals of Artificial Intelligence and Machine Learning (TCS364), Deep Learning(TCS464), Reinforcement Learning (TCS545)		

9. Course Outcome:	After completion of the course, the students will be able to: CO1: Define fundamental concepts in generative modeling and explain the core idea behind Generative Adversarial Networks. CO2: Describe the different components of a GAN architecture and their functionalities. CO3: Implement basic GAN architectures using popular deep learning libraries relevant to engineering problems. CO4: Compare and contrast the strengths and weaknesses of different GAN variants for specific image generation tasks. CO5: Discuss the potential regulatory and societal impacts of GANs and related generative models. CO6: Design and implement a basic GAN system for a simple engineering-related problems.
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10. Details of the Course:

Sl. No.	Contents	Contact Hours
1	UNIT 1: Introduction to GANs, GAN Components Overview of generative models, The concept and architecture of GANs- Applications and implications of GANs, Deep learning preliminaries for GANs, The discriminator and generator models, Loss functions in GANs	10

2	UNIT 2: Training GANs Challenges in training GANs, Techniques for stable GAN training, Evaluation metrics for GANs	9
3	UNIT 3: Variants of GANs Conditional GANs, Deep Convolutional GANs (DCGAN), CycleGAN and Pix2Pix	9
4	UNIT 4: Advanced GAN Applications GANs for image synthesis and manipulation, GANs for data augmentation, GANs in creative and artistic domains	9
5	UNIT 5: Ethical and Societal Implications Ethical considerations of generative models, Misuse potential of GAN technology, Regulatory and societal impacts	8
Total		45

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Jakub Langr, Vladimir Bok	GANs in Action: Deep learning with Generative Adversarial Networks	1 st Edition	Manning, USA	2019
Josh Kalin	Generative Adversarial Networks Cookbook	1 st Edition	Packt Publishing, UK	2018
David Foster	Generative Deep Learning: Teaching Machines to Dream	1st Edition	O'Reilly Media, USA	2019

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Jasmijn Tran, Sergio Ortega, and Antonio García Yepes	Hands-On Generative Adversarial Networks with Keras	1st Edition	Packt Publishing Ltd, UK	2019
John Hany	Hands-On Generative Adversarial Networks with PyTorch 1.x	1st Edition	Packt Publishing, India	2019

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
TCS665.1	Define fundamental concepts in generative modeling and explain the core idea behind Generative Adversarial Networks	1	2	-	-	-	-	-	-	-	-	-	2	2	1	1
TCS665.2	Describe the different components of a GAN architecture and their functionalities	-	-	-	3	-	-	-	-	-	-	-	2	3	1	1
TCS665.3	Implement basic GAN architectures using popular deep learning libraries relevant to engineering problems	-	-	-	3	-	-	-	-	-	-	-	2	3	2	1
TCS665.4	Compare and contrast the strengths and weaknesses of different GAN variants for specific image generation tasks	-	2	-	1	-	-	-	-	-	-	-	1	1	1	1
TCS665.5	Discuss the potential regulatory and societal impacts of GANs and related generative models	-	-	2	-	-	-	-	-	-	-	-	1	1	1	1
TCS665.6	Design and implement a basic GAN system for a simple engineering-related problems	-	-	3	3	-	-	-	-	-	-	-	3	3	2	1
TCS665		1	2	2.5	2.5	-	-	-	-	-	-	-	1.83	2.16	1.33	1

High correlation (3); Medium correlation (2); Low correlation (1), No correlation (-)

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI

Name of Department: - Computer Science and Engineering

1.	Subject Code:	TCS666	Course Title:	Transformer Models and Applications				
2.	Contact Hours:	L: 3	T: 0	P: 0				
3.	Examination Duration (Hrs):	Theory 3	Practical 0					
4.	Relative Weight:	CIE 25	MSE 25	ESE 50				
5.	Credits:	3						
6.	Semester:	VI						
7.	Category of Course:	DSC						
8.	Pre-requisite:	Natural Language Processing (TSC564), Deep Learning (TCS464)						

9. Course Outcome:	After completion of the course, the students will be able to: CO1: Define the fundamental concepts of transformer models and their key components like self-attention and multi-head attention. CO2: Describe the functionalities of positional encoding, layer normalization, and feed-forward networks in transformers. CO3: Implement basic transformer architectures using popular deep learning libraries relevant to engineering problems. CO4: Compare and contrast the strengths and weaknesses of various transformer applications in NLP tasks like machine translation and text summarization. CO5: Evaluate the scalability challenges associated with large transformer models and discuss approaches like model distillation for efficiency. CO6: Design and implement a simple transformer-based system for an engineering-related problem like sentiment analysis or text classification.
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10. Details of the Course:

Sl. No.	Contents	Contact Hours
1	UNIT 1: Introduction to Transformers, Building Blocks of Transformers Overview of transformer architecture, Self-attention mechanism: concept and advantages, Positional encoding and layer normalization, Detailed	10

	study of multi-head attention, The role of feed-forward networks in transformers, Masking and its uses in model training	
2	UNIT 2: Training Transformers Optimization and regularization techniques, Handling large datasets and batch processing, Strategies for effective training and convergence	8
3	UNIT 3: Applications in NLP Machine translation and text summarization, Text generation with GPT models, BERT and its variants for various NLP tasks	10
4	UNIT 4: Beyond NLP Vision Transformers (ViT) for image recognition, Transformer applications in audio processing, Cross-modality transformers for joint tasks	10
5	UNIT 5: Advanced Topics and Future Directions Scalability of transformers and big model issues, Efficient transformers and model distillation, Ethical considerations and biases in large models	8
	Total	46

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Denis Rothman	Transformers for Natural Language Processing	1st Edition	MANNING Publications Co., USA	2021
Lewis Tunstall, Leandro von Werra, and Thomas Wolf	Natural Language Processing with Transformers	1st Edition	O'Reilly Media, Inc., USA	2020

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Aurélien Géron	Hands-On Transformers with Python	1st Edition	O'Reilly Media, Inc., USA	2021

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
TCS666.1	Define the fundamental concepts of transformer models and their key components like self-attention and multi-head attention	1	-	-	2	-	-	-	-	-	-	-	1	2	2	1
TCS666.2	Describe the functionalities of positional encoding, layer normalization, and feed-forward networks in transformers	2	1	-	-	-	-	-	-	-	-	-	2	2	2	1
TCS666.3	Implement basic transformer architectures using popular deep learning libraries relevant to engineering problems	-	-	2	3	3	-	-	-	-	-	-	2	3	2	1
TCS666.4	Compare and contrast the strengths and weaknesses of various transformer applications in NLP tasks like machine translation and text summarization	-	2	-	2	-	-	-	-	-	-	-	1	1	1	1
TCS666.5	Evaluate the scalability challenges associated with large transformer models and discuss approaches like model distillation for efficiency	2	-	-	2	-	-	-	-	-	-	-	3	2	1	1
TCS666.6	Design and implement a simple transformer-based system for an engineering-related problem like sentiment analysis or text classification	-	-	3	3	-	-	-	-	-	-	-	2	3	2	2
TCS 666		1.66	1.5	2.5	2.4	3	-	-	-	-	-	-	1.83	2.16	1.66	1.166

High correlation (3); Medium correlation (2); Low correlation (1), No correlation (-)

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VI (ELECTIVE)

Name of Department: - Computer Science and Engineering

1.	Subject Code:	TCS645	Course Title:	AI in Creative Fields				
2.	Contact Hours:	L: 3	T: 1	P: 0				
3.	Examination Duration (Hrs):	Theory 3		Practical 0				
4.	Relative Weight:	CIE 25	MSE 25	ESE 50				
5.	Credits:	3						
6.	Semester:	VI						
7.	Category of Course:	DSE						
8.	Pre-requisite:	Fundamentals of Artificial Intelligence and Machine Learning (TCS364)						

9. Course Outcome:	After completion of the course, the students will be able to: CO1: Identify various AI-powered techniques used in creative fields like art, music, writing, video, and games. CO2: Explain the core principles behind AI-based creative techniques like neural style transfer and AI music composition. CO3: Differentiate between ethical and unethical considerations regarding copyright and authorship in AI-generated creative content. CO4: Assess the potential benefits and limitations of AI in NPC behavior modeling and procedural content generation for games. CO5: Evaluate the cultural impact of AI on the arts and media, considering aspects of social acceptance and potential resistance. CO6: Propose a creative project that utilizes AI in a specific creative field (e.g., AI-powered music composition for a specific genre) while considering ethical and societal implications.
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10. Details of the Course:

Sl. No.	Contents	Contact Hours
1	UNIT 1: AI in Art Overview of AI-generated techniques like neural style transfer and deep dream, Case studies of AI art installations and collaborations	10
2	UNIT 2: AI in Music	10

	Fundamentals of AI music composition, Systems like WaveNet and OpenAI's Jukebox, Ethical and copyright considerations in AI-generated music	
3	UNIT 3: AI in Writing and text AI for writing assistance and content generation, Exploration of GPT and other text-based models, Impact on publishing, journalism, and media	8
4	UNIT 4: AI in Videos and Film AI applications in video editing and film production, Automated video generation and CGI enhancements, AI's role in narrative construction and visual effects	10
5	UNIT 5: AI in Gaming, Cultural and Societal Implications AI-driven game design and development, Non-player character (NPC) behavior modeling- Procedural content generation and dynamic storytelling, Cultural impacts of AI in the arts, Societal acceptance and resistance to AI in creative fields, Future directions and potentials of creative AI	10
	Total	48

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Richard Boulanger	AI for Artists and Musicians	1st Edition	O'Reilly Media, Inc., USA	2020
Maureen Fan	AI and the Future of Storytelling	1st Edition	MIT Press, USA	2018

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Marcus du Sautoy	The Creativity Code: Art and Innovation in the Age of AI	1st Edition	HarperCollins Publishers, UK	2019
Ian Millington and John Romero	AI for Games	1st Edition	O'Reilly Media, Inc., USA	2008

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
TCS645.1	Identify various AI-powered techniques used in creative fields like art, music, writing, video, and games	-	2	-	-	-	-	-	-	-	-	-	1	2	1	1
TCS645.2	Explain the core principles behind AI-based creative techniques like neural style transfer and AI music composition	-	2	-	-	2	-	-	-	-	-	-	1	2	1	1
TCS645.3	Differentiate between ethical and unethical considerations regarding copyright and authorship in AI-generated creative content	-	-	-	2	-	-	-	-	-	-	-	1	1	1	1
TCS645.4	Assess the potential benefits and limitations of AI in NPC behavior modeling and procedural content generation for games	-	-	-	2	-	-	-	-	-	-	--	2	2	1	1
TCS645.5	Evaluate the cultural impact of AI on the arts and media, considering aspects of social acceptance and potential resistance	2	-	-	2	-	2	-	-	-	-	-	1	2	1	1
TCS645.6	Propose a creative project that utilizes AI in a specific creative field (e.g., AI-powered music composition for a specific genre) while considering ethical and societal implications	2	1	3	2	-	2	-	-	-	-	-	3	3	2	1
TCS645		2	1.66	3	2	2	2	-	-	-	-	-	1.5	2	1.16	1

High correlation (3); Medium correlation (2); Low correlation (1), No correlation (-)

2023-24 and 2024-25 onwards

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1.	Subject Code:	TCS643	Course Title:	Theory of Optimization		
2.	Contact Hours:	L: 3	T: 1	P: 0		
3.	Examination Duration (Hrs):	Theory 4		Practical 0		
4.	Relative Weight:	CIE 25	MSE 25	ESE 50		
5.	Credits:	3				
6.	Semester:	VII				
7.	Category of Course:	DSE				
8.	Pre-requisite:	Linear Algebra, Calculus				

9. Course Outcome:	After completion of the course the students will be able to: CO1: develop a knowledge in the field of optimization techniques and their basic concepts, principles and algorithms. CO2: understand fundamentals of linear programming, Integer programming and Dynamic programming. CO3: apply the theory of optimization methods for modelling various types of decision-making problems. CO4: solve the mathematical results and numerical algorithms of optimization theory to concrete Engineering problems
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10. Details of the Course:

Sl. No.	Contents	Contact Hours
1	Unit 1: Basic Concepts: Formulation of mathematical programming problems; Classification of optimization problems; Optimization techniques – classical and advanced techniques Optimization using Calculus: Convexity and concavity of functions of one and two variables; Optimization of function of multiple variables subject	10

	to equality constraints; Lagrangian function; Optimization of function of multiple variables subject to equality constraints; Hessian matrix formulation	
2	Unit 2: Linear Programming: Standard form of linear programming (LP) problem; Canonical form of LP problem; Assumptions in LP Models; Graphical method for two variable optimization problem; Motivation of simplex method, Simplex algorithm and construction of simplex tableau; Revised simplex method; Duality in LP; Primal dual relations; Dual Simplex Method; Sensitivity or post optimality analysis; bounded variables	10
3	Unit 3: Dynamic Programming: Representation of multistage decision process; Types of multistage decision problems; Concept of sub optimization and the principle of optimality	8
4	Unit 4: Integer Programming: Integer linear programming; Branch and Bound algorithm; Concept of cutting plane method; Mixed integer programming; Solution algorithms.	8
5	Unit 5: Advanced Topics in Optimization: Direct and indirect search methods; Heuristic and Meta-Heuristic Search methods; Multi objective optimization.	8
	Total	

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
S.S. Rao	Engineering Optimization: Theory and Practice	3 rd	New Age International Publishers, Dehli	2013
H.A. Taha	Operations Research: An Introduction	10 th	Pearson Education, India	2019
Ravindran, K. M. Ragsdell and G. V. Reklaitis	Engineering Optimization: Methods and Applications	2 nd	Wiley India	2006

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
R. Fletcher	Practical Methods of Optimization	2 nd	Wiley India	2009
K. Deb	Optimization for Engineering Design	2 nd	Prentice Hall India	2012

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
TCS643.1	develop a knowledge in the field of optimization techniques and their basic concepts, principles and algorithms.	-	-	3	-	-	-	-	-	-	-	-	2	2	1	1
TCS643.2	understand fundamentals of linear programming, Integer programming and Dynamic programming.	1	2	-	2	-	-	-	-	-	-	-	1	2	2	1
TCS643.3	apply the theory of optimization methods for modelling various types of decision-making problems.	-	-	3	-	-	-	-	-	-	-	-	2	3	2	1
TCS643.4	solve the mathematical results and numerical algorithms of optimization theory to concrete Engineering problems	3	-	1	-	-	-	-	-	-	-	-	3	3	2	1
TCS643.5																
TCS643.6																
TCS643		2	2	2.33	2	-	-	-	-	-	-	-	2	2.5	1.75	1

High correlation (3); Medium correlation (2); Low correlation (1), No correlation (-)

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1.	Subject Code:	TCS765	Course Title:	Large Language Models		
2.	Contact Hours:	L: 3	T: 0	P: 0		
3.	Examination Duration (Hrs):	Theory 3		Practical 0		
4.	Relative Weight:	CIE 25	MSE 25	ESE 50		
5.	Credits:	3				
6.	Semester:	VII				
7.	Category of Course:	DSC				
8.	Pre-requisite:	Deep Learning(TCS464), Generative Adversarial Networks (TCS665)				

9. Course Outcome:	After completion of the course, the students will be able to: CO1: Identify the core components of LLMs, such as the transformer architecture and attention mechanisms. CO2: Describe the optimization techniques and challenges associated with training large language models. CO3: Differentiate between various applications of LLMs in natural language understanding and generation tasks. CO4: Analyze case studies of successful LLM fine-tuning applications and identify the key factors for success. CO5: Evaluate regulatory and societal considerations surrounding the development and use of large language models. CO6: Critically assess the ethical implications of deploying LLMs, including potential biases and fairness concerns.
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10. Details of the Course:

Sl. No.	Contents	Contact Hours
1	UNIT 1: Foundations of LLMs, Training LLMs Overview of large language models, Evolution from early models to advanced LLMs, Core concepts: Transformer architecture, attention mechanisms Data requirements and preprocessing for training LLMs, Optimization techniques and challenges in training, Use of hardware and computation resources	10

2	UNIT 2: Application of LLMs Natural language understanding and generation, Implementation in chatbots and virtual assistants, Use cases in translation, summarization, and content creation	10
3	UNIT 3: Fine-Tuning and Adaptation Techniques for fine-tuning LLMs on specific tasks, Adapting pre-trained models to new domains, Case studies of successful fine-tuning applications	10
4	UNIT 4: Ethical Considerations and Bias Ethical implications of deploying LLMs, Addressing bias and fairness in language models, Regulatory and societal considerations	8
5	UNIT 5: Future Directions and Innovations Emerging trends in the development of LLMs, Potential breakthroughs in AI and language understanding, Scalability and environmental impacts of LLM training	8
Total		46

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Raj Arun R	Mastering Large Language Models with Python: Unleash the Power of Advanced Natural Language Processing for Enterprise Innovation and Efficiency Using Large Language Models (LLMs) with Python	1 st Edition	Orange Education Pvt Ltd, India	2024
Ben Auffarth	Generative AI with LangChain: Build large language model (LLM) apps with Python, ChatGPT and other LLMs	1 st Edition	Packt Publishing, India	2023
Valentina Alto	Building LLM Powered Applications: Create intelligent apps and agents with large language models	1 st Edition	Packt Publishing, India	2024

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
TCS765.1	Identify the core components of LLMs, such as the transformer architecture and attention mechanisms	1	2	-	1	-	-	-	-	-	-	-	2	3	2	1
TCS765.2	Describe the optimization techniques and challenges associated with training large language models	2	1	-	-	-	-	-	-	-	-	-	2	2	2	1
TCS765.3	Differentiate between various applications of LLMs in natural language understanding and generation tasks	-	2	-	2	-	-	-	-	-	-	-	1	1	1	1
TCS765.4	Analyze case studies of successful LLM fine-tuning applications and identify the key factors for success	-	3	-	-	-	-	-	-	-	-	-	2	3	2	1
TCS765.5	Evaluate regulatory and societal considerations surrounding the development and use of large language models	2	-	3	-	-	-	-	-	-	-	-	2	3	2	1
TCS765.6	Critically assess the ethical implications of deploying LLMs, including potential biases and fairness concerns	-	2	-	-	-	3	-	-	-	-	-	2	3	2	2
TCS765		1.66	2	3	1.5	-	3	-	-	-	-	-	1.83	2.5	1.83	1.16

High correlation (3); Medium correlation (2); Low correlation (1), No correlation (-)

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII

Name of Department: - Computer Science and Engineering

1.	Subject Code:	TCS766	Course Title:	Multimodal AI
2.	Contact Hours:	L: 3	T: 0	P: 0
3.	Examination Duration (Hrs):	Theory 3	Practical 0	
4.	Relative Weight:	CIE 25	MSE 25	ESE 50
5.	Credits:	3		
6.	Semester:	VII		
7.	Category of Course:	DSC		
8.	Pre-requisite:			

9. Course Outcome:	After completion of the course, the students will be able to: CO1: Define the concept of multimodal AI and its key characteristics. CO2: Explain the significance of combining multiple data types in AI systems and the challenges associated with multimodal data processing. CO3: Analyze case studies on effective multimodal representation learning for specific tasks. CO4: Compare and contrast different machine learning models used for multimodal learning tasks. CO5: Evaluate the potential benefits and limitations of multimodal AI in specific application domains like healthcare, retail, and entertainment. CO6: Propose a novel application of multimodal AI in an engineering field, considering the relevant data modalities, potential challenges, and ethical implications.
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10. Details of the Course:

Sl. No.	Contents	Contact Hours
1	UNIT 1: Introduction to Multimodal AI, Data Fusion Techniques Overview of multimodal AI systems, Significance and applications of combining multiple data types, Challenges in multimodal data processing	10

	- Early, late, and hybrid fusion techniques, Feature-level and decision-level fusion, Applications in enhancing model performance	
2	UNIT 2: Multimodal Representations Creating joint representations from different modalities, Techniques like embedding and canonical correlation analysis, Case studies on effective representation learning	10
3	UNIT 3: Multimodal Machine Learning Models Neural networks for multimodal learning, Use of transformers in multimodal contexts, Integration of vision and language (ViLBERT, CLIP)	10
4	UNIT 4: Applications of Multimodal AI Healthcare: Integrating medical imaging and textual reports, Retail: Combining customer behavior and sensory data, Entertainment: Enhancing user experience through audio-visual data integration	10
5	UNIT 5: Challenges and Future Directions Addressing disparities in modality dominance, Scalability and computational demands, Ethical considerations in multimodal AI applications	8
	Total	48

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Ben Auffarth	Generative AI with LangChain: Build large language model (LLM) apps with Python, ChatGPT and other LLMs	1 st Edition	Packt Publishing, India	2023
Sinan Ozdemir	Quick Start Guide to Large Language Models: Strategies and Best Practices for Using ChatGPT and Other LLMs	1st Edition	Addison-Wesley Professional, USA	2023

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
TCS766.1	Define the concept of multimodal AI and its key characteristics	1	2	-	-	-	-	-	-	-	-	-	2	2	1	1
TCS766.2	Explain the significance of combining multiple data types in AI systems and the challenges associated with multimodal data processing	1	-	2	1	-	-	-	-	-	-	-	-	2	1	1
TCS766.3	Analyze case studies on effective multimodal representation learning for specific tasks	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
TCS766.4	Compare and contrast different machine learning models used for multimodal learning tasks	-	2	-	2	-	-	-	-	-	-	-	1	1	1	1
TCS766.5	Evaluate the potential benefits and limitations of multimodal AI in specific application domains like healthcare, retail, and entertainment	2	-	-	2	-	2	-	-	-	-	-	1	2	1	1
TCS766.6	Propose a novel application of multimodal AI in an engineering field, considering the relevant data modalities, potential challenges, and ethical implications	2	1	3	2		2	-	-	-	-	-	3	3	2	1
TCS766		1.5	2	2.5	1.75	-	2	-	-	-	-	-	1.75	2	1.2	1

High correlation (3); Medium correlation (2); Low correlation (1), No correlation(-)

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII (ELECTIVE)

Name of Department: - Computer Science and Engineering

1.	Subject Code:	TCS745	Course Title:	Advanced GANs		
2.	Contact Hours:	L: 3	T: 0	P: 0		
3.	Examination Duration (Hrs):	Theory		3	Practical	
4.	Relative Weight:	CIE	25	MSE	25	ESE
5.	Credits:	3				
6.	Semester:	VII				
7.	Category of Course:	DSE				
8.	Pre-requisite:	Generative Adversarial Networks (TCS665)				

9. Course Outcome:	After completion of the course, the students will be able to: CO1: Define different types of advanced GAN architectures, including Progressive Growing GANs and StyleGAN. CO2: Describe the working mechanism of autoregressive models like PixelRNN and PixelCNN for image generation. CO3: Identify potential applications of diffusion models in creative fields like generative art or commercial applications like product design. CO4: Analyze the potential ethical concerns surrounding the use of deep learning models for audio generation. CO5: Assess the effectiveness of different training techniques and hyperparameter settings for advanced GANs. CO6: Design and implement a basic generative model using a specific framework for a chosen creative task.
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10. Details of the Course:

SI. No.	Contents	Contact Hours
1	UNIT 1: Advanced GANs, Variational Autoencoders (VAEs) Progressive growing of GANs, StyleGAN and its variants, Applications of advanced GANs in high-resolution image synthesis, Theory behind VAEs, Building and training VAE models, Applications of VAEs in generative tasks	10

2	UNIT 2: Diffusion Models Introduction to diffusion processes in generative models, Implementing and training diffusion models, Creative and commercial applications of diffusion models	10
3	UNIT 3: Autoregressive Models Overview of autoregressive models like PixelRNN and PixelCNN, Applications in pixel-level image generation, Challenges and optimizations in autoregressive models	10
4	UNIT 4: Generative Models for Audio Deep learning models for audio generation, WaveNet and its applications-Generating music and speech with neural networks	10
5	UNIT 5: Ethics and Future of Generative AI Ethical considerations of using generative models, Potential misuses and societal impacts, Future trends and emerging technologies in generative AI	8
Total		48

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Jakub Langr, Vladimir Bok	GANs in Action: Deep learning with Generative Adversarial Networks	1 st Edition	Manning, USA	2019
Josh Kalin	Generative Adversarial Networks Cookbook	1 st Edition	Packt Publishing, UK	2018
David Foster	Generative Deep Learning: Teaching Machines to Dream	1 st Edition	O'Reilly Media, USA	2019

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Jasmijn Tran, Sergio Ortega, and Antonio García Yépes	Hands-On Generative Adversarial Networks with Keras	1 st Edition	Packt Publishing Ltd, UK	2019
John Hany	Hands-On Generative Adversarial Networks with PyTorch 1.x	1 st Edition	Packt Publishing, India	2019

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
TCS745.1	Define different types of advanced GAN architectures, including Progressive Growing GANs and StyleGAN	1	2	-	-	2	-	-	-	-	-	-	2	2	1	1
TCS745.2	Describe the working mechanism of autoregressive models like PixelRNN and PixelCNN for image generation	2	1	-	-	2	-	-	-	-	-	-	2	2	2	1
TCS745.3	Identify potential applications of diffusion models in creative fields like generative art or commercial applications like product design	2	2	2	-	-	-	-	-	-	-	1	2	2	1	1
TCS745.4	Analyze the potential ethical concerns surrounding the use of deep learning models for audio generation	-	3	-	2	-	-	-	-	-	-	-	2	3	2	1
TCS745.5	Assess the effectiveness of different training techniques and hyperparameter settings for advanced GANs	-	-	2	-	-	-	-	-	--	-	-	2	2	2	1
TCS745.6	Design and implement a basic generative model using a specific framework for a chosen creative task	-	-	3	3	-	-	-	-	-	-	-	3	3	2	1
TCS745		1.66	2	2.33	2.5	2	-	-	-	-	-	1	2.16	2.33	1.66	1

High correlation (3); Medium correlation (2); Low correlation (1), No correlation (-)

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER VII (ELECTIVE)

Name of Department: - Computer Science and Engineering

1.	Subject Code:	TCS743	Course Title:	Evolutionary Computation
2.	Contact Hours:	L: 3	T: 1	P: 0
3.	Examination Duration (Hrs):	Theory 4	Practical 0	
4.	Relative Weight:	CIE 25	MSE 25	ESE 50
5.	Credits:	3		
6.	Semester:	VII		
7.	Category of Course:	DSE		
8.	Pre-requisite:	TCS 302 Data Structures with C		
9.	Course Outcome:	After completion of the course the students will be able to: CO1: Understand the relations between the most important evolutionary algorithms. CO2: Understand the implementation issues of evolutionary algorithms. CO3: Determine the appropriate parameter settings to make different evolutionary algorithms work well. CO4: Design new evolutionary operators, representations, and fitness functions		

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1	Introduction to Models and Concept of Computational Intelligence, Social Behavior as Optimization: Discrete and Continuous Optimization Problems, Classification of Optimization Algorithms, Optimization background and terminology: Gradient optimization methods, sampling methods, linear programming, combinatorial optimization. Evolutionary Biology background: Genotype and	10

	phenotype, unit of selection, genes and traits, chromosomes, alleles, diploid and haploid, fitness, mutation and recombination.	
2	Selection, variation and landscapes. The strengths and weaknesses of the evolutionary model. Inductive bias. The No free lunch theorem. Genetic Algorithms: Representation, operators, and standard algorithm. Evolutionary strategies: Evolution in continuous variables. Transformations. Genetic Programming.	8
3	Building blocks and architecture-altering operators. Libraries and Trees. Selection mechanisms: Fitness proportionate, rank, tournament, Stochastic Universal Sampling and Boltzman selection methods. Niching methods. Spatial methods. Artificial landscapes and test functions: The Two-armed bandit problem. Gene Expression Programming, Multi-modal and deceptive functions. Royal roads. N-k landscapes.	8
4	Hierarchical and fractal functions. Pareto evolution. Co-evolution: Multiple populations and single-population co-evolution, Multiobjective evolutionary algorithms: Plasticity and life-time learning. Lamarckian learning, The Baldwin effect. Symbiosis as a source of evolutionary innovation. Macro-mutations, Tabu Search: Tabu Tenure, Cycle Detection & Aspiration Criterion, Reactive Tabu Search.	8
5	Swarm Intelligence Techniques: Particle Swarm Optimization, Ant Colony Optimization, Artificial Bees and Firefly Algorithm, Hybridization and Comparisons of Swarm Techniques, Application of Swarm Techniques in Different Domains and Real-World Problems	8
	Total	

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Melanie Mitchell	An introduction to genetic algorithms	1 st Edition	Manning, USA	1998
A.P. Engelbrecht	Computational Intelligence: Introduction	An	2 nd Edition	Wiley, India

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
D. E. Goldberg	Genetic Algorithm in Search Optimization and Machine Learning	1st Edition	Pearson Education, India	2008

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
TCS745.1	Define different types of advanced GAN architectures, including Progressive Growing GANs and StyleGAN	1	2	-	-	2	-	-	-	-	-	-	2	2	1	1	
TCS745.2	Describe the working mechanism of autoregressive models like PixelRNN and PixelCNN for image generation	2	1	-	-	2	-	-	-	-	-	-	2	2	2	1	
TCS745.3	Identify potential applications of diffusion models in creative fields like generative art or commercial applications like product design	2	2	2	-	-	-	-	-	-	-	1	2	2	1	1	
TCS745.4	Analyze the potential ethical concerns surrounding the use of deep learning models for audio generation	-	3	-	2	-	-	-	-	-	-	-	2	3	2	1	
TCS745.5	Assess the effectiveness of different training techniques and hyperparameter settings for advanced GANs	-	-	2	-	-	-	-	-	-	-	-	2	2	2	1	
TCS745.6	Design and implement a basic generative model using a specific framework for a chosen creative task	-	-	3	3	-	-	-	-	-	-	-	3	3	2	1	
TCS745		1.66	2	2.33	2.5	2	-	-	-	-	-	-	1	2.16	2.33	1.66	1

High correlation (3); Medium correlation (2); Low correlation (1), No correlation (-)