GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER III

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS-344** Course Title: **Probability and Random Processes**
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: (**TMA 101) Engineering Mathematics I, (TMA 201) Engineering Mathematics II**

9. **Course Outcome:**	After completion of the course the students will be able to**:** CO1: To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems in communication engineering. CO2: To understand the basic concepts of probability, one-dimensional and two-dimensional random variables and to introduce some standard distributions applicable to engineering which can describe real life phenomenon. CO3: To understand the basic concepts of random processes which are widely used in IT fields. CO4: To understand the concept of correlation and spectral densities. CO5:To understand the significance of linear systems with random inputs.

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** PROBABILITY AND RANDOM VARIABLES Probability – Axioms of probability – Conditional probability – Baye‘s theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.	9
2	**Unit 2:** TWO - DIMENSIONAL RANDOM VARIABLES distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).	9
3	**Unit 3:** RANDOM PROCESSES Classification Stationary process – Markov process - Markov chain - Poisson process – Random telegraph process.	9
4	**Unit 4:** CORRELATION AND SPECTRAL DENSITIES Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.	9
5	**Unit 5:** LINEAR SYSTEMS WITH RANDOM INPUTS Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and cross correlation functions of input and output.	9
	Total	**45**

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Oliver C. Ibe	Fundamentals of Applied Probability and Random Processes	1st	Elsevier, Indian Reprint	2007
Peebles. P.Z.	Probability, Random Variables and Random Signal Principles	4th	McGraw Hill Education, American	2017

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Yates. R.D. and Goodman. D.J	Probability and Stochastic Processes	3rd	Wiley India	2021
Stark. H., and Woods. J.W	Probability and Random Processes with Applications to Signal Processing	3rd	Pearson education india	2002

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
TCS344.1	To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems in communication engineering.	1	2		1								2	3	2	1
TCS344.2	To understand the basic concepts of probability, one-dimensional and two-dimensional random variables and to introduce some standard distributions applicable to engineering which can describe real life phenomenon.	1		2	1									2	1	1
TCS344.3	To understand the basic concepts of random processes which are widely used in IT fields.			3										3	1	1
TCS344.4	To understand the concept of correlation and spectral densities.		3										2	3	2	1
TCS344.5	To understand the significance of linear systems with random inputs.	3				2								2	2	1
TCS 344		1.67	2.50	2.50	1.00	2.00	-	-	-	-	-	-	2.00	2.60	1.60	1.00

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: **TCS 442** Course Title: **Automated Reasoning**
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: **IV**
7. Category of Course: **DSE**
8. Pre-requisite: **TCS 344 Probability and Random Process**

9. **Course Outcome:**	After completion of the course the students will be able to**:** CO1: represent mathematical and other knowledge using logical formalism CO2: understand the history of formalizing mathematical knowledge CO3: know and understand the advantages and limitations of the main approaches and techniques in automated reasoning of mathematical knowledge CO4: apply different automated reasoning techniques to new problems

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1**: Introduction and motivation: Role of logic in Computer Science, problem representation. Basic notions: language, models, interpretations, validity, proof, decision problems in logic. decidability.	8

2	**Unit 2:** Propositional logic: Syntax, semantics, proof systems, Validity, satisfiability and unsatisfiability, soundness and completeness.	8
3	**Unit 3:** Mechanization: truth tables, normal forms, semantic tableau, resolution, proof by contradiction, example. First order predicate logic theory: Quantifiers, first order models, validity and satisfiability, semantic tableaux.	8
4	**Unit 4:** Normal forms, skolemization: Elimination of quantifiers, unification, resolution and various resolution strategies, equality axioms and para-modulation. Horn formulas and programs.	8
5	**Unit 5:** Prolog as a restricted resolution-based theorem prover. Undecidability and incompleteness in logic, compactness Theorem.	8
	Total	**40**

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Michael Huth and Mark Ryan	Logic in Computer Science: Modelling and Reasoning about Systems	**2nd**	**Cambridge University Press, Kingdom of England**	2005
Arindama Singh	Logics for Computer Science	**2nd**	Prentice Hall of India	2020

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
M. Ben-Ari	Mathematical Logic for Computer Science	**3rd**	**Springer Publisher ,German**	**2012**
Elliott Mendelson	Introduction to Mathematical Logic	**6th**	**CRC Press, United States**	**2015**

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
TCS442.1	Represent mathematical and other knowledge using logical formalism	1	2										2	2	1	1
TCS442.2	Understand the history of formalizing mathematical knowledge		2										1	2	2	1
TCS442.3	Know and understand the advantages and limitations of the main approaches and techniques in automated reasoning of mathematical knowledge	2			2								2	2	2	1
TCS442.4	Apply different automated reasoning techniques to new problems				2								1	3	1	1
TCS442		1.50	2.00	-	2.00	-	-	-	-	-	-	-	1.50	2.25	1.50	1.00

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

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS 542** Course Title: **Introduction to Artificial Intelligence**
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: **V**
7. Category of Course: **DSE**
8. Pre-requisite: TCS 343 Mathematical Foundations for Artificial Intelligence

9. **Course Outcome:**	After completion of the course the students will be able to**:** CO 1: Understand the basics of the theory and practice of Artificial Intelligence. CO 2: Learn the basics of Artificial Intelligence programming. CO 3: Understand various searching techniques use to solve the AI problems. CO 4: Apply knowledge representation techniques and problem solving strategies to common AI applications. CO 5: Build self-learning and research skills to tackle a topic of interest on his/her own or as part of a team. CO 6: Apply the knowledge of AI and agents in developing multidisciplinary real world projects

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1: Introduction** What is AI? , Foundation of AI, State space representation. Intelligent Systems: Categorization of Intelligent System, Components of AI Program, Types of AI, Foundations of AI, Applications of AI, Current trends in AI, Intelligent Agents: Anatomy, structure, Types.	8
2	**Unit 2: Problem Solving** Solving problem by Searching: Problem Solving Agent, Formulating Problems. Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS), Depth Limited Search, Depth First Iterative Deepening (DFID), Informed Search Methods: Greedy best first Search, A* Search, Memory bounded heuristic Search. Local Search Algorithms and Optimization Problems: Hill climbing search Simulated annealing, Local beam search	10
3	**Unit 3: Uncertain Knowledge and Reasoning** Acting under uncertainty, Basic Probability Notation, Inference using full joint distributions, Bayes Rule and its use.	8
4	**Unit 4: Knowledge Representation** First order predicate calculus, Horn Clauses, Introduction to PROLOG, Semantic NetsPartitioned Nets, Minskey frames, Case Grammar Theory, Production Rules KnowledgeBase, The Inference System, Forward & Backward Deduction	10
5	**Unit 5: Expert System and Programing Language** Expert System Existing Systems (DENDRAL, MYCIN), domain exploration, Meta Knowledge, Expertise Transfer, Self Explaining System	12

	Programming Language: Introduction to programming Language, LISP, PROLOG	
	Total	**48**

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
G F. Luger	Artificial Intelligence: Structures and Strategies for Complex Problem Solving,	6th	Pearson/Addison-Wesley, American	2021
Dan W. Patterson	Introduction to Artificial Intelligence and Expert Systems	1st	PHI Learning,India	1990
Eileen Mc Daniel, Stephen McDaniel	The Accidental Analyst: Show Your Data Who's Boss Freak Analytics	1st	Freakalytics, LLC,USA	2012

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Stuart J. Russell and Peter Norvig	Artificial Intelligence a Modern Approach	3rd	McGraw Hill Education, American	2009

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
TCS542.1	Understand the basics of the theory and practice of Artificial Intelligence.		2	2	2								1	2	2	1
TCS542.2	Learn the basics of Artificial Intelligence programming.	2		2									2	2	1	1
TCS542.3	Understand various searching techniques use to solve the AI problems.			3									2	3	2	1
TCS542.4	Apply knowledge representation techniques and problem solving strategies to common AI applications.	2			3								1	3	2	2
TCS542.5	Build self-learning and research skills to tackle a topic of interest on his/her own or as part of a team.		2		2		2					3	1	2	1	1
TCS542.6	Apply the knowledge of AI and agents in developing multidisciplinary real world projects	1	1	3		3			3				3	3	2	2
TCS 542		2.00	2.00	2.33	2.33	-	2.00	-	-	-	-	3.00	1.40	2.40	1.60	1.20

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

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

Name of Department: - Computer Science and Engineering

1. Subject Code: **TCS542** Course Title: **Artificial Intelligence Lab**
2. Contact Hours: **L:** **0** **T**: **1** **P**: **2**
3. Examination Duration (Hrs): **Theory** **0** **Practical** **3**
4. Relative Weight: **CIE** **25** **MSE** **25** **ESE** **50**
5. Credits: **1**
6. Semester: **V**
7. Category of Course: **DSE**
8. Pre-requisite: TCS 409 Design and Analysis of Algorithm, TCS 341Python programming for computing

9. **Course Outcome:**	After completion of laboratory the students will be able to**:** **CO1:** Implement methods in AI **CO2:** Analyze AI algorithms and applications

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	To program problem-solving by path traversal search over graph using BFS, DFS, UFS	2
2	To program problem-solving by path traversal using A* algorithm (Informed Search)	2
2	To use lobe.ai user interface and perform manual labeling, training and testing for supervised object recognition in Image	2

3	To understand and develop basic KR (Knowledge Representation) tools from practical AI problem definitions: KR methods	2
4	To take two - category input data file and use thresholding to design binary classifier for dataset 1 dimensional, 2 dimensional dataset	2
5	To register and use monkeylearn.com and create model, train and classify sentiments that lead to sentiment prediction using corpus of hotel reviews as part of NLU	2
6	To register and use Teachable machine (Google API) and perform multiple class / pose analysis and classification.	2
7	To use quillbot.com and study basic machine transcription roles in summarization: as NLP application	2
8	To use quillbot.com and study basic machine transcription roles in grammar checker (syntax): as NLP application	2
9	To use quillbot.com and study basic machine transcription roles in paraphrasing: as NLP application	2
10	Program probabilistic model given: it is Friday and that a student is absent is 3 %. Since there are 5 school days in a week, the probability that it is friday is 20 %. What is the probability that a student is absent given that today is friday. Program Bayesian rule in python to get the result.	2
11	To extract intra-day stock market data for 4 stocks and write program that: plots the values, develops linear regression, derive mean and correlation.	2
12	To program best fit distributions for at least 2 discrete distributions and estimate mean and variance for the dataset.	2
13	To program best fit distributions for at least 2 continuous distributions and estimate mean and variance for the dataset.	2
14	To program method using Z score, DB for detection of Outliers in dataset	2
15	To study role of correlation as strong, weak and moderate between underlying features as function of sample size	2
16	To develop knowledge discovery and association rule map for healthcare dataset	2
	Total	32

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
G F. Luger	Artificial Intelligence: Structures and Strategies for Complex Problem Solving,	6th	Pearson/Addison-Wesley, American	2021
Dan W. Patterson	Introduction to Artificial Intelligence and Expert Systems	1st	PHI Learning,India	1990
Eileen Mc Daniel, Stephen McDaniel	The Accidental Analyst: Show Your Data Who's Boss Freak Analytics	1st	Freakalytics, LLC,USA	2012

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Stuart J. Russell and Peter Norvig	Artificial Intelligence a Modern Approach	3rd	McGraw Hill Education, American	2009

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PCS542.1	Implement methods in AI															
PCS542.2	Analyze AI algorithms and applications															
PCS542.3																
PCS542.4																
PCS542.5																
PCS542.6																
TCS 542																

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

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

SEMESTER V

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** **4** **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: (TCS 409) Design Analysis and Algorithm, (TCS 343) Mathematical Foundations for Artificial Intelligence

9. **Course Outcome:**	After completion of the course the students will be able to**:** CO1: Use logic programming and knowledge representation languages for modelling simple application domains in Artificial Intelligence CO2: Apply reasoning mechanisms in knowledge representation languages to test the correctness of models and to formulate more expressive queries. CO3: Design ontology-based knowledge systems with reasoning mechanism; integrate with other systems for building applications. CO4: Understand the entire process of how to design, construct, and query a knowledge graph to solve real-world problems.

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	Introduction to Description Logic	1st	Cambridge University Press, Kingdom of England	2017
Ronald Brachman & Hector Levesque	Knowledge Representation and Reasoning	1st	Morgan Kaufmann Publishers, United States	2004
Frank van Harmelen, Vladimir Lifschitz and Bruce Porter (Eds)	Handbook of Knowledge Representation Foundations of Artificial Intelligence	1st	Elsevier,India	2008

Ian Robinson, Jim Webber, Emil Eifrem	Graph Databases	2nd	O'Reilly,United Kingdom	2015

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Pascal Hitzler, Markus Kroetsch, and Sebastian Rudolph	Foundations of Semantic Web Technologies, Chapman & Hall/ CRC Textbooks in Computing	1st	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	1		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.		2			2							1	2	1	1
TCS543.3	Design ontology-based knowledge systems with reasoning mechanism; integrate with other systems for building applications.		2			2							1	2	1	1
TCS543.4	Understand the entire process of how to design, construct, and query a knowledge graph to solve real-world problems.		2										1	2	1	1
TCS 543		1.00	2.00	2.00	-	2.00	-	-	-	-	-	-	1.00	1.75	1.00	1.00

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: **TCS 662** Course Title: **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: **VI**
7. Category of Course: **DSC**
8. Pre-requisite: Design and Analysis of Algorithm (TCS 409), Fundamental of Statistics and AI (TCS 421), Statistical Data Analysis with R (TCS 471), Discrete Structures and Combinatorics (TMA 316)

9. **Course Outcome:**	After completion of the course the students will be able to**:** **CO1:** Acquire concepts and methods in statistical machine learning **CO2:** Analyze fundamental principles of machine learning algorithms **CO3**: Understand machine learning motivated by case-studies **CO4:** Investigate and evaluate key topics in machine learning algorithms for data science industry

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1: Machine learning foundation** Review of logic and knowledge system - language, axiom, hypothesis, theorem, logic & types, what is ML, Inductive bias in ML, AI pyramid, Pattern classification pipeline, Linear algebra in ML, Probabilistic logic and statistical inference (Random expt./ variable, CDF, WLLN, Bayes, Markov & Chernoff bound,	14

	Hypothesis testing and performance indices - ROC, Estimation - detection, Optimality of Bayes, bias-variance, underfit-overfit, entropy as Information, Cover's packing lemma, Curse of dimensionality, **Case study:** Wealth – optimal payoffs in portfolios (stock market)	
2	**<u>Unit 2:</u> Unsupervised Learning** Clustering, Clustering methods – Partition vs. Hierarchical, k-Means and k-Medoids, Hierarchical: Agglomerative & Divisive, Error Analysis in Clustering, Ensemble - clustering, **Case study:** Clustering in Health care, Causal cluster, Graph cluster	8
3	**<u>Unit 3:</u> Supervised Learning** Main objectives and types of Supervised methods (Parametric, Semi parametric, Non-parametric), Linear Regression and Weiner filter, Grammar based/ Inductive learning - Decision Trees – CART, ID-3, Pruning metrics for tree; D-tree examples, Linear SVM (basics and V-C bound), k-NN rule and examples, Learning as Factorization, Ensemble learning: Bagging, Boosting**. Case studies:** covered for mentioned Supervised learning techniques.	10
4	**<u>Unit 4:</u> Reinforcement & Interaction Learning** Basic model of Reinforcement Learning as game (Agent, Critic, Environment), Optimal policy & Q – values, Bellman equation, **Case studies** on R Learning Active learning, Deep Reinforcement, Transfer learning with examples, Federated Machine Learning with examples.	8
5	**<u>Unit 5:</u> Special topics in Machine Learning** Sentiment Mining: NLP pipeline process, Data Analytics – Big data and Hadoop model, Business Analytics – Competitive Machine Learning, ANN building blocks (problem solving), Deep learning, Feed forward, Backpropagation, C-NN, Recurrent-NN.	8
	Total	**48**

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
R, Duda, P. Hart and D. Stork	Pattern classification	2nd	Wiley Publisher,India	2007
J. Friedman, R. Tibshirani and T. Hastie	The Elements of Statistical Learning	3rd	Springer Publisher ,German	2007
C. Bishop	Pattern Recognition and Machine Learning	2nd	Springer Publisher ,German	2016
A. Courville, I. Goodfellow, Y. Bengio	Deep Learning	2nd	MIT Press,United States	2016

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Tom M. Mitchell	Machine Learning	1st	McGraw Hill Education, American	2017
E. Alpaydin	Introduction to Machine Learning	3rd	PHI Learning,India	2015
T M. Cover, J A. Thomas	Elements of Information Theory	2nd	Wiley Publisher,India	2006

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
TCS662.1	Acquire concepts and methods in statistical machine learning	1	2										2	2	1	1
TCS662.2	Analyze fundamental principles of machine learning algorithms				3								2	3	1	1
TCS662.3	Understand machine learning motivated by case-studies			3									2	3	2	1
TCS662.4	Investigate and evaluate key topics in machine learning algorithms for data science industry	1	3										2	3	2	1
TCS662		1.00	2.50	3.00	3.00	-	-	-	-	-	-	-	2.00	2.75	1.50	1.00

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: **PCS 662** Course Title: **Machine Learning Lab**
2. Contact Hours: **L:** **0** **T**: **1** **P**: **2**
3. Examination Duration (Hrs): **Theory** **0** **Practical** **3**
4. Relative Weight: **CIE** **25** **MSE** **25** **ESE** **50**
5. Credits: **1**
6. Semester: **VI**
7. Category of Course: **DSC**
8. Pre-requisite: (TCS-341) Python Programming for Computing,**(TCS-342) Introduction to Statistical Data Science**

9. **Course Outcome:**	After completion of the course the students will be able to**:** **CO1:** Implement methods in statistical machine learning **CO2:** Analyze data and machine learning algorithms **CO3**: Understand machine learning motivated by case-studies

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	To implement various similarity functions for attribute tuples stored as .csv file – Euclidean, Manhattan, Cosine.	1
2	To use lobe.ai user interface and perform manual labeling, training and testing for supervised object recognition in Image	2
3	To understand and develop basic KR (Knowledge Representation) Tools from practical AI problem definitions: KR methods	3
4	To take two - category input file and use thresholding to design binary classifier for 1 feature, for 2 feature dataset	4

5	To register and use monkeylearn.com and create model, train and classify sentiments that lead to sentiment prediction using corpus of hotel reviews as part of NLU	5
6	To register and use Teachable machine (Google API) and perform multiple class / pose analysis and classification.	6
7	To use quillbot.com and study basic machine transcription roles in summarization: as NLP application	7
8	To use quillbot.com and study basic machine transcription roles in grammar checker (syntax): as NLP application	8
9	To use quillbot.com and study basic machine transcription roles in paraphrasing: as NLP application	9
10	To create multiple clusters using PoS (parts of speech) data by reading input text file	10
11	To create multiple clusters from column data entries of .csv file using k-means algorithm	11
12	To create multiple clusters by using hierarchical clustering – Agglomerative based on .csv file	12
13	To use healthcare dataset and form scatter plot with observed statistical measures	13
14	To import tabular data for related clinical parameters and program a basic linear regression model	14
15	Program probabilistic model given: it is Friday and that a student is absent is 3 %. Since there are 5 school days in a week, the probability that it is friday is 20 %. What is the probability that a student is absent given that today is friday. Program Bayesian rule in python to get the result.	15
16	To extract intra-day stock market data for 4 stocks and write program that: plots the values, develops linear regression, derive mean and correlation.	16
17	To write program that can import training samples for 3 labels and perform k-NN for new queries and quantify error performance	17
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 to equality constraints; Lagrangian function; Optimization of function of multiple variables subject to equality constraints; Hessian matrix formulation	10

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	3rd	New Age International Publishers,India	2013
H.A. Taha	Operations Research: An Introduction	10th	Pearson Education,India	2019
Ravindran, K. M. Ragsdell and G. V. Reklaitis	Engineering Optimization: Methods and Applications	2nd	Wiley India	2006

Reference Books:

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

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PCS662.1	Implement methods in statistical machine learning	1	2										2	2	1	1
PCS662.2	Analyze data and machine learning algorithms	1		2	1								2	2	1	1
PCS662.3	Understand machine learning motivated by case-studies			3									3	3	2	1
PCS 662		1.00	2.00	2.50	1.00	-	-	-	-	-	-	-	2.33	2.33	1.33	1.00

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: **TCS 643** Course Title: **Theory of Optimization**
2. Contact Hours: **L:** **3** **T**: **1** **P**: **0**
3. Examination Duration (Hrs): **Theory** **3** **Practical** **1**
4. Relative Weight: **CIE** **25** **MSE** **25** **ESE** **50**
5. Credits: **3**
6. Semester: **V**
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

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	3rd	New Age International Publishers,India	2013
H.A. Taha	Operations Research: An Introduction	10th	Pearson Education,India	2019
Ravindran, K. M. Ragsdell and G. V. Reklaitis	Engineering Optimization: Methods and Applications	2nd	Wiley India	2006

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
R. Fletcher	Practical Methods of Optimization	2nd	Wiley India	2009
K. Deb	Optimization for Engineering Design	2nd	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			2									1	1	1	1
TCS643.2	understand fundamentals of linear programming, Integer programming and Dynamic programming.	1		3									2	3	2	1
TCS643.3	apply the theory of optimization methods for modelling various types of decision-making problems.			3									3	3	2	1
TCS643.4	solve the mathematical results and numerical algorithms of optimization theory to concrete Engineering problems		2		2								2	2	1	1
TCS 643		1.00	2.00	2.67	2.00	-	-	-	-	-	-	-	2.00	2.25	1.50	1.00

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: **TCS 663** Course Title: **Big Data Analytics: Tools and Techniques**
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: **VI**
7. Category of Course: **DSE**
8. Pre-requisite:

9. **Course Outcome:**	After completion of the course the students will be able to: CO1: Investigate Hadoop related tools for Big Data Analytics and perform basic Hadoop Administration CO2: Analyse the technological foundations for Big data with Hadoop and design of Hadoop distributed file system CO3: Understand the concept of MapReduce workflow CO4: Develop program using Hive and Apache Pig for large data processing CO5: Outline the theory of big data, and explain applications of big data CO6: Build Big Data Analytics application to solve real world problem

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** **Introduction to Hadoop:** Introduction to Hadoop, Distributed Computing Challenges, Hadoop Features, Hadoop Distributed File System (HDFS), Hadoop Versions, Hadoop Installation, HDFS basic commands, Overview of Hadoop Ecosystem, RDMS vs Hadoop	9
2	**Unit 2:** **Introduction to MapReduce Programming:** Introduction to MapReduce Framework, Mapper, Reducer, Combiner, Partitioner, Searching, Sorting, Compression, Sample programs on MapReduce, Techniques to optimize MapReduce Jobs	8
3	**Unit 3: Hive and Apache Pig** **Hive:** Introduction to Hive, Hive Architecture, Hive Data Types, Hive Query Language, User Defined Functions, Sample Programs **Apache Pig:** Introduction to Pig, Pig Latin Overview, Data Types in Pig, Pig Operators, User Defined Functions, Sample Programs	8
4	**Unit 4:** **Spark:** Introduction to Spark, Features of Spark, Spark Architecture, Spark Components, Spark RDD, Spark in-built functions, Sample Programs	9
5	**Unit 5: Apache Flume, Sqoop and Big Data Applications** **Flume:** Introduction to Apache Flume, Flume Architecture, Data Flow, Environment, Sample Exercise **Sqoop:** Introduction to Sqoop, Sqoop Features, Sqoop Architecture, Sqoop integration with Hadoop, Data import and export using Sqoop, Sqoop vs Flume, Sample Exercise **Big Data Applications:** Healthcare, Agriculture, Education, Media and Entertainment, Travel, Retail, etc.	8
	Total	**42**

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Subhashini Chellappan Seema Acharya	Big Data and Analytics	2nd	Wiley, India	2019
MapReduce, Hive, YARN, Pig	Big Data, Black Book: Covers Hadoop 2	1st	Dreamtech Press, New Dehli	2016
Raj Kamal	Big Data Analytics, Introduction to Hadoop, Spark, and Machine-Learning	1st	McGraw Hill Education, American	2019

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Tom White	Hadoop: The Definitive Guide	4th	O'Reilly,United Kingdom	2015
Michele Chambers, Michael Minelli , Ambiga Dhiraj	Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses	1st	Wiley, India	2013

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
TCS663.1	Investigate Hadoop related tools for Big Data Analytics and perform basic Hadoop Administration	1	2										2	2	1	1
TCS663.2	Analyse the technological foundations for Big data with Hadoop and design of Hadoop distributed file system				3								2	3	1	1
TCS663.3	Understand the concept of MapReduce workflow				3								2	3	2	1
TCS663.4	Develop program using Hive and Apache Pig for large data processing		2		1								1	1	1	1
TCS663.5	Outline the theory of big data, and explain applications of big data			2									1	1	1	1
TCS663.6	Build Big Data Analytics application to solve real world problem			3	3								3	3	2	1
TCS 663		1.00	2.00	2.50	2.50	-	-	-	-	-	-	-	1.83	2.17	1.33	1.00

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: **TCS 742** Course Title: **Deep 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: **VII**
7. Category of Course: **DSC**
8. Pre-requisite:

9. **Course Outcome:**	After completion of the course the students will be able to: CO1: To understand the fundamental concepts and principles of deep learning. CO2: To evaluate and use the most important concepts and the methods in the area ML and deep learning. CO3: Examine modern practical deep networks. CO4: Know deep Learning Research Areas. CO5: Use software libraries of deep learning CO6: Use deep learning models.

10. **Details of the Course:**

Sl. No.	Contents	Contact Hours
1	**Unit 1:** Introduction to deep learning: basics of Machine Learning, Machine Learning vs Deep Learning, deep learning process, neural network,	8

2	**Unit 2:** Modern practical deep networks: Deep Feed forward Networks, Regularization for Deep Learning, Optimization for Training Deep Models, Convolutional Networks, Variants of CNN: DenseNet, PixelNet	9
3	**Unit 3:** Popular CNN Architectures: ResNet, AlexNet, Sequence Modeling: Recurrent and Recursive Nets, Practical Methodology, Applications, Transfer learning Techniques,	9
4	**Unit 4:** Deep Learning Research: Linear Factor Models, Auto-encoders, Representation Learning, Structured Probabilistic Models for Deep Learning, Monte Carlo Methods, Confronting the Partition Function, Approximate Inference Deep Generative Models.	8
5	**Unit 5:** Deep Learning Platforms and Software Libraries: What is a Deep Learning Platform? H2O.ai, Data GraphLab, Deep Learning Libraries, Theano, Caffe, TensorFlow	10
	Total	**44**

Text Books:

Authors Name	Title	Edition	Publisher, Country	Year
Josh Patterson, Adam Gibson	Deep Learning: A Practitioner's Approach	1st	O'Reilly,United Kingdom	2017
Umberto Michelucci	Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks	1st	A press,India	2018
Giancarlo Zaccone, Md. Rezaul Karim, Ahmed Menshawy	Deep Learning with TensorFlow: Explore neural networks with Python	1st	Packt Publishing Limited, UK	2017

Reference Books:

Authors Name	Title	Edition	Publisher, Country	Year
Josh Patterson and Adam Gibson	Deep Learning A Practitioner	1st	O'Reilly,United Kingdom	2017

Course Articulation Matrix

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
TCS742.1	To understand the fundamental concepts and principles of deep learning.	1			2								1	2	2	1
TCS742.2	To evaluate and use the most important concepts and the methods in the area ML and deep learning.	2	1										2	2	2	1
TCS742.3	Examine modern practical deep networks.			2	3	3							2	3	2	1
TCS742.4	Know deep Learning Research Areas.		2		2								1	1	1	1
TCS742.5	Use software libraries of deep learning	2			2								3	2	1	1
TCS742.6	Use deep learning models.			3	3								2	3	2	2
TCS 742		1.67	1.50	2.50	2.40	3.00	-	-	-	-	-	-	1.83	2.17	1.67	1.17

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