MALNAD COLLEGE OF ENGINEERING, HASSAN

(An Autonomous Institution Affiliated to VTU, Belagavi)

Autonomous programme

Bachelor of Engineering

DEPARTMENT OF

COMPUTER SCIENCE AND ENGINEERING

SCHEME and SYLLABUS

VII Semester & VIII Semester

(2022-23 Admitted Batch)

Academic Year 2025-2026

VISION

To become a prominent department of Computer Science & Engineering producing competent professionals with research and innovation skills, inculcating moral values and societal concerns.

MISSION

1. Impart world class engineering education to produce technically competent engineers.
2. Provide facilities and expertise in advanced computer technology to promote research.
3. Enhance Industry readiness and entrepreneurial abilities through innovative skills
4. Nurture ethical values and social responsibilities

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1 : Graduates will be efficient software developers in diverse fields and will be successful professionals and/or pursue higher studies.

PEO 2 : Graduates will be capable to adapt to new computing technology for professional excellence and Research and will be lifelong learners.

PEO 3 : Graduates will work productively exhibiting ethical qualities for the betterment of society.

PEO 4 : Graduates will possess leadership qualities, work harmoniously in a team with effective communication skills.

PROGRAM OUTCOMES

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, andan engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

Upon graduation, students with a degree B.E. in Computer Science & Engineering will be able to:

PSO – 1: To make the students industry ready by facilitating them with software tools in recent technologies

PSO – 2: To develop IT based solutions for problems in diverse domains

Scheme and Syllabus for IV Year

SEVENTH SEMESTER					
Course Category	**Course Code**	**Course Title**	**L-T-P**	**Credits**	**Contact Hours**
IPCC	22CS701	System Software and Compiler Design	2-2-0	3	4
PCC	22CS702	Network Security and Cyber Law	3-0-0	3	3
PCC	22CS703	Main Project Phase - II	0-0-4	2	4
PI	22CS77X	Professional Elective Course - III	3-0-0	3	3
PEC	22CS78X	Professional Elective Course - IV	3-0-0	3	3
OEC	22OECS7X	Open Elective - II	3-0-0	3	3
			Total	**17**	**20**

Sl. No.	**Professional Elective Course - III**		**Sl. No.**	**Professional Elective Course - IVI**	
	Course Code	**Course Title**		**Course Code**	**Course Title**
1.	22CS771	Deep Learning	1.	22CS781	Pattern Recognition
2.	22CS772	Data Science	2.	22CS782	Big Data Analytics
3.	22CS773	Mobile Communications	3.	22CS783	Cloud Computing
4.	22CS774	Software Testing	4.	22CS784	Green Computing

Sl. No.	**Open Electives**	
	Course Code	**Course Title**
1.	22OECS71	Introduction to Data Science
2.	22OECS72	IOT and its Applications
3.	22OECS73	Introduction to Big Data

EIGHTH SEMESTER					
Course Category	**Course Code**	**Course Title**	**L-T-P**	**Credits**	**Contact Hours**
PEC	22WS01	Professional Elective (Online Course)	3-0-0	3	3
PEC	22WS02	Open Elective (Online course)	3-0-0	3	3
PI	22INT3	Internship (Research / Industry)(14-20 weeks)	0-0-24	10	24
			Total	**16**	**30**

Course Title	SYSTEM SOFTWARE AND COMPILER DESIGN		
Course Code	22CS701	L-T-P-C	(2-2-0) 3
Exam Hrs.	3	Hours / Week	4
CIE	50 Marks	SEE	50 Marks
		Total Hours	50

Course Objective:	To get acquainted with the features of system software and the various phases of compiler design.
Course Outcomes (COs):	Upon the completion of the course the students will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	Describe the concepts of system software and the features of various machine architectures.	1	-
2.	Demonstrate the functions and features of an assembler used to generate the object program.	2,3	-
3.	Apply the concepts of Loaders, Linkers and Macro Processors for a given problem	2,3	-
4.	Apply Lexical and Syntactic analysis for a given grammar.	3,4,5	1

Course Contents:

MODULE – 1	10 Hrs
Machine Architecture, Assembler 1: The Simplified Instructional Computer (SIC) Assemblers: Basic assembler functions, Machine dependent assembler features. Assembler 2: Machine Independent Assembler Features, Assembler Design Options.	
MODULE – 2	**10 Hrs**
Loaders and Linkers: Basic Loader Functions, Machine-Dependent Loader Features, Machine-Independent Loader Features, Loader Design Options. Macro Processor: Basic Macro Processor Functions, Machine-Independent Macro Processor Features.	
MODULE – 3	**10 Hrs**
Introduction: Language Processors, The structure of a Compiler, Applications of Compiler Technology, Programming Language Basics. Lexical Analysis: Role of Lexical Analyzer, Input buffering, Specifications of tokens, Recognition of Tokens.	
MODULE – 4	**10 Hrs**
Syntax Analysis: Introduction, Context –free Grammar and Structure of Language, Parser and its Types, Top- Down parser-Recursive descent parsing and Non-Recursive descentparsing, Predicting parsing table, Error recovering strategies.	

Tutorial

1. a) Write and execute a LEX program to count the number of characters, words, spaces & no. of lines in a given input file.
   b) Write a LEX program to count the number of comment lines in a given C program. Also eliminate them and copy that program into separate file.
2. Write a LEX program to recognize a valid arithmetic expression and to recognize the identifiers and operators present and to print them separately.
3. a) Write a LEX program to recognize and count the number of identifiers in a given input file.
   b) Write a LEX program to find & replace String.
4. a) Write a LEX program to check the validity of a Date.

b) Write LEX program by reading input file and copy the content with line number to another file.

5. Write YACC program to recognize a valid arithmetic expression that uses operators +, -,* & /.
6. Write YACC program to evaluate an arithmetic expression involving operators +, -, * and /.
7. Write a YACC program to convert infix to postfix.
8. a) Write YACC program to recognize the grammar (a^nb, n >= 10).
   b) Write a YACC Program to recognize the grammar ($a^nb^mc^k$, m,n,k >=0 and m=n+k).

Text Book :

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	System Software – An Introduction to Systems Programming	Leland Beck, D. Manjula	3rd	Pearson Education	2013
2.	Compilers- Principles, Techniques and Tools	Alfred V Aho, Ravi Sethi, Jeffrey D Ullman		Addison-Wesley	2013

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Systems Programming and Operating Systems	D. M. Dhamdhere	2nd	Tata McGraw Hill Company	2009
2.	Systems Programming	John J. Donovan	2nd	Tata McGraw Hill Company	2000
3.	Lex and Yacc	John. R. Levine, Tony Mason and Doug Brown		O'Reilly, SPD	2012
4.	Principles of Compiler Design	S. V. Raghavan		Tat McGraw Hill Education	2010

MOOC:
https://in.udacity.com/course/compilers-theory-and-practice--ud168

Proposed Assessment Plan (for 50 marks of CIE):

Tool		Remarks	Marks
CIE	CIE1	Conducted for 20 marks(Module 1) & reduced to 10 marks	10
	CIE2	Conducted for 20 marks(Module 2) & reduced to 10 marks	10
	CIE3	Conducted for 20 marks(Module 3) & reduced to 10 marks	10
Activity Details		Lab test and Object code generation activity	20

Course Articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	2	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	2	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	3	2	2	-	-	-	-	-	-	-	3	-

Course Title	NETWORK SECURITY AND CYBER LAW		
Course Code	22CS702	L-T-P-C	(3-0-0) 3
Exam Hrs.	3	Hours/Week	3
CIE	50 Marks	SEE	50 Marks
		Total Hours	40

Course Objective:	To learn cryptography techniques, cyber law, IPR, and IT Act**.**
Course Outcomes(COs):	Upon the completion of the course the students will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	Describe the various types of Security attacks and Ciphers	1, 12	-
2.	Develop and apply the Traditional and Modern Block Ciphers	3, 4	2
3.	Analyse the Symmetric and Asymmetric key Cryptography Algorithms	2, 4	-
4.	Assess the new strategies and regulations of Cyber law and IT act	6, 8	

Course Contents:

MODULE–1	10Hrs

Introduction: Security goals, Cryptographic attacks, Services and Mechanisms, Techniques for security goals implementation, **Mathematics of cryptography**: Integer Arithmetic, The Extended Euclidean Algorithm; **Traditional Symmetric-Key Ciphers:** Symmetric-Key Ciphers**,** Categories of traditional ciphers.
Self-Study Component (Not included in SEE):: Modular Arithmetic, Matrices and Linear Congruence

MODULE–2	10Hrs

Stream and Block ciphers**; Introduction to Modern Symmetric-Key Ciphers:** Modern block ciphers, Components of modern block ciphers, Two classes of Product Ciphers, Attacks designed for block ciphers.; **Data Encryption Standard**: History and Data Encryption Standard, DES Structure, DES Analysis, Security of DES, Multiple DES-Conventional Encryption Algorithm.
Self-Study Component (Not included in SEE): Mathematics of Symmetric-Key cryptography: Field and GF (2n) Fields.

MODULE–3	10Hrs

The CAST Block Cipher, Data Encryption Standard Blowfish, IDEA**; Advanced Encryption Algorithm:** History and Advanced Encryption Algorithm, Transformation used by AES; **Asymmetric Key cryptography:** Difference between symmetric cryptography and asymmetric Key cryptography Cryptosystem, RSA cryptosystem, Rabin Cryptosystem ;
Self-Study Component (Not included in SEE): Mathematics of Asymmetric-Key cryptography: Primes, Primality testing, Factorization, Chinese Remainder Theorem.

MODULE–4	10Hrs

Security and Cyber Law: INTRODUCTION: Cyberspace , Cyber security, Cyber security Policy , Cyber Crime, Nature of Threat , Enabling People, Mission and Vision of Cyber security Program , OBJECTIVES : Emerging Trends of Cyber Law , Create Awareness , Areas of Development , International Network on Cyber security; **Intellectual Property Rights**: Types of Intellectual Property Rights, Advantages of Intellectual Property Rights, Intellectual Property Rights in India, Intellectual Property in Cyber Space; **The information Technology Act -** IT act aim and objectives, Scope of the act, Major Concepts, Important provisions, Attribution, acknowledgement, and dispatch of electronic records, Secure electronic records and secure digital signatures, Regulation of certifying authorities: Digital Signature certificates, Duties of Subscribers, Penalties and adjudication.

Text Book :

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Cryptography and Network Security	Behrouz A Forouzan, Debdeep Mukhopadhyay	3rd	McGraw Hill Education	2017
2.	Cryptography, Network Security and Cyber Laws	Bernard Menezes	1st	Cengage Learning	2010

Reference Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Introduction to Cryptography: Principles and Applications	Hans Delfs, Helmut Knebl	1st	Springer	
2.	Number theory and cryptography	Neal Koblitz	1st	Springer	2007
3.	Cryptography and Network Security	William Stallings	5th	Pearson Education	2013

MOOCs:

1. http://nptel.ac.in/courses/106105031/
2. https://www.edx.org/learn/cybersecurit
3. https://www.tutorialspoint.com/information_security_cyber_law/index.htm

Proposed Assessment Plan (for 50 marks of CIE):

Tool		Remarks	Marks
CIE	CIE	Conducted for 20 marks and reduced to 10 marks	10
	CIE	Conducted for 20 marks and reduced to 10 marks	10
	CIE	Conducted for 20 marks and reduced to 10 marks	10
Activity Details		Group Based Activity	**20**

Course Articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-		-	-	-	-	-	-	-	-	2	-	-
CO2	-	-	3	2	-	-	-	-	-	-	-	-	-	2
CO3	-	3	-	2	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	3	2		-	-	-	-	-	

MAIN PROJECT PHASE - II			
Course Code	**22CS703**	**L-T-P-C**	**(0-0-8) 4**
Exam Hrs.	**3**	**Hours / Week**	**4**
SEE	**50 Marks**	**Total Hours**	**-**

Course Objective: Design and implement solution for the identified real world problem in Phase I**.**
Course Outcomes (COs): Upon completion of course the students will be able to

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	Implement the design with appropriate techniques, resources and contemporary tools for solving the chosen problem	3,4,5	1,2
2.	Communicate effectively as a team member and make presentations and publish technical document.	9,10,11,12	-
3.	Use ethical practices in all activities related to project implementation.	8,9	-
4.	Demonstrate the ability to effectively collaborate with in a team to address societal and environmental aspects through technology	6,7,9,10	1,2

The project teams will implement the project started in their seventh semester

The project work is to be evaluated in three stages:

- Stage I (30M) - First internal evaluation shall be taken up during this phase. This includes presentation on fine tuning of SRS & Design carried out in seventh semester.
- Stage II (20 M) – Mid phase evaluation shall be taken up during this phase. This includes presentation, intermediate project demonstration, draft copy of the technical paper.
- Stage III (50 M) – Final project Demo, report submission and details of technical paper publication.
- The evaluation of the project stages shall be carried out by the evaluation committee comprising of project guide & other faculty members. The committee will be constituted by the project coordinator in consultation with the Head of the department. ***For Multidisciplinary projects guides will be allotted from each concerned branch***.

Students shall strictly adhere to the project policy document announced in the beginning of the semester

Rubrics for Evaluation of project

Stage I (Project Progress):

Evaluation of Main Project Phase II is carried out by evaluation committee.

Sl. No.	Performance Indicators	Average	Good	Excellent	Max marks
1.	SRS	Inappropriate information. (1-2)	Not in accordance to the format. (3-4)	Appropriate information in correct format. (5)	05
2	System design and development	System specification is not identified. (0 – 3)	System specification is identified but not satisfactory. (4 – 6)	System specification is identified correctly. (7 – 10)	05
2.	Identification of appropriate tool for application	Application tools are not identified. (0 – 3)	Application tools identified but not used. (4 – 6)	Application tools identified and used. (7 – 10)	10

3.	Oral presentation	Entire contents not delivered. (1-2)	Contents not delivered clearly. (3-4)	Contents delivered clearly with confidence. (5)	5
4.	Group Participation	Did less work than others. Listened mainly; Rarely spoke up, and ideas were off the mark. Needed much reminding; submission was late. (1-2)	Did almost as much work as others. Participated in discussions; on some occasions, made suggestions. Completed assigned work on time. (3-4)	Did a full share of the work or more and volunteers to help others? Provided many good ideas; inspired others; clearly communicated ideas and needs. Completed assigned work ahead of time. (5)	5
				Total	**30**

Stage II (Mid Phase Project Demonstration with Draft paper):

Evaluation of this phase is done by evaluation committee.

Sl. No.	Performance Indicator	Average	Good	Excellent	Total marks allocated
1.	Design and Implementation	Design not complete. (1-2)	Design partially completed. (3-4)	Design completed. (5)	5
2.	Intermediate Demonstration	Incomplete. (1-2)	Complete but not satisfactory. (3-4)	Complete and satisfactory. (5)	5
3.	Technical paper Draft	Organization and technical content not relevant. (1-2)	Organization and technical content of paper complete but needs improvement. (3-4)	Organization and technical content of the report are complete and satisfactory. (5)	5
4.	Oral presentation	Presentation slides are not clear. (1-2)	Presentation slides are clear, but not satisfactory. (3-4)	Presentation slides are clear and satisfactory. (5)	5
				Total	**20**

Stage III (Final Project Demonstration):

Evaluation of this phase is done by evaluation committee.

Sl. No.	Performance Indicator	Average	Good	Excellent	Total marks allocated
1.	Final project demonstration	Project incomplete (0 – 3)	Project complete but needs improvement in interface design/ functionality, etc. (4-6)	Project completed (7-10)	10

2.	Oral Presentation	Disorganized and ineffective presentation (4)	Organized, but ineffective presentation (7)	Effective organized presentation (10)	5
3.	Ethics	Upholds the standards of honesty and integrity.(1-2)	Upholds the standards of honesty and integrity. Addressed few societal and environmental issues(3-4)	Upholds the standards of honesty and integrity. Addressed the societal and environmental issues and responsibilities.(5)	5
4.	Report submission	Disorganized and contents are not sufficient (0-8)	Organized but not good content wise (9-14)	Effectively organized and well framed contents (15-20)	20
5.	Technical paper publication/KSCST/Any Proposal Submitted (Granted) to VGST/DST/University/ sponsoring agency	Paper submitted for National Conference (8)	Paper submitted / published in an International Conference (9)	Paper submitted / published in a Journal (10)	10
				Total	**50**

Proposed Assessment Plan (for 50 marks of CIE):

Tool	Remarks	Marks
Phases	Phase 1 Evaluation	20
	Phase 2 Evaluation	30
	Phase 3 Evaluation	50

Course Articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	3	3	3	-	-	-	-	-	-	-	3	3
CO2	-	-	-	-	-	-	-	-	3	3	3	3	-	3
CO3	-	-	-	-	-	-	-	3	3	-	-	-	-	-
CO4	-	-	-	-	-	3	3	-	3	3	-	-	3	3

Course Title	DEEP LEARNING		
Course Code	22CS771	L-T-P	(3-0-0)3
Exam	3	Hours/Week	3
CIE	50 Marks	SEE	50 Marks
		Total Hours	40

Course Objective:	Deploy deep learning algorithms and their applications to solve real world problems.
Course Outcomes (COs):	At the end of the course, student will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	Describe the fundamentals of deep learning algorithms	1	1
2.	Apply suitable deep learning algorithms for the given problem.	3	2
3.	Use tensor-flow and keras for training the models.	3,5	2
4.	Solve problems using Deep Neural networks, CNN and RNN.	3,4,5,9,10	1, 2

Course Contents :

MODULE-1	10 Hrs

Introduction to Artificial Neural Networks with Keras- From Biological to Artificial Neurons, Biological Neurons, Logical Computations with Neurons, Architectures of Neural Network, Learning Process in ANN, The Perceptron, MultiLayer Perceptron (MLP) and Backpropagation, Types of Activation Functions, Regression MLps, Classification MLPs.

Implementing MLP's with Keras, : Installing TensorFlow 2, Building an Image Classifier Using the Sequential API, Building a Regression MLP Using the Sequential API, Building Complex Models Using the Functional API, Saving and Restoring a Model, Using Callbacks, Visualization Using TensorBoard, Fine-Tuning Neural Network Hyperparameters

MODULE-2	10 Hrs

Training Deep Neural Networks- Vanishing/Exploding Gradients, Glorot and He Initialization, Nonsaturating Activation Functions, Batch Normalization, Gradient Clipping, Reusing Pretrained Layers, Transfer Learning With Keras, Unsupervised Pretraining, Pretraining on an Auxiliary Task.

Faster Optimizers, Momentum Optimization, Nesterov Accelerated Gradient, AdaGrad, RMSProp, Adam and Nadam Optimization, Learning Rate Scheduling. Avoiding Overfitting Through Regularization, $\ell 1$ and $\ell 2$ Regularization, Dropout, Monte-Carlo (MC) Dropout, Max-Norm Regularization.

MODULE-3	10 Hrs

Loading and Preprocessing Data with TensorFlow – The Data API, Chaining Transformations, Shuffling the Data, Preprocessing the Data, Putting Everything Together, Prefetching, Using the Dataset With tf.keras. The TF Record Format, Compressed TFRecord Files, A Brief Introduction to Protocol Buffers, TensorFlow Protobufs, Loading and Parsing Examples, Handling Lists of Lists Using the Sequence Example Protobuf. The Features API, TF Transform, The TensorFlow Datasets (TFDS) Project.

Deep Computer Vision Using Convolutional Neural Networks - Architecture of Visual Cortex, Convolutional Layer, Filters, Stacking Multiple Feature Maps, TensorFlow Implementation, Memory Requirements, Pooling Layer, TensorFlow Implementation.

MODULE-4	10 Hrs

Deep Computer Vision Using Convolutional Neural Networks : CNN Architectures, LeNet-5, AlexNet, GoogLeNet, VGGNet, ResNet, Xception, SENet, Implementing a ResNet-34 CNN Using Keras, Using Pretrained Models From Keras, Pretrained Models for Transfer Learning, Classification and Localization, Object Detection: Fully Convolutional Networks (FCNs), You Only Look Once (YOLO), Semantic Segmentation

Processing Sequences Using RNNs and CNNs - Recurrent Neurons and Layers, Training RNNs, Forecasting a Time Series, Baseline Metrics, Implementing a Simple RNN.

Text Book :

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Hands-On Machine Learning with Scikit-Learn-Keras and Tensor Flow: Concepts, Tools and Techniques to Build Intelligent Systems	Aurelien Geron	2nd		2019

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Python Machine Learning	Sebastian Raschka and Vahid Mirjalili	3rd		

e-Book:
https://www.oreilly.com/library/view/hands-on-machine-learning/9781492032632/

MOOCs:
1. https://www.edx.org/course/deep-learning-with-tensorflow
2.https://www.deeplearning.ai/tensorflow- in-practice/

Proposed Assessment Plan (for 50 marks of CIE):

Tool		Remarks	Marks
CIE	CIE-1	Conducted for 20 marks(Module 1) & reduced to 10 marks	10
	CIE-2	Conducted for 20 marks(Module 2) & reduced to 10 marks	10
	CIE-3	Conducted for 20 marks(Module 3) & reduced to 10 marks	10
Activity Details	Act	Project Based activity	20

Course Articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2	-	-	2	-	-	-	-	-	3	-	-	-	-	3
CO3	-	-	3	-	3	-	-	-	3	3	-	-	-	3
CO4	-	-	2	2	3	-	-	-	2	2	-	-	2	3

Course Title	DATA SCIENCE		
Course Code	22CS772	L-T-P-C	(3-0-0)3
Exam Hrs.	3	Hours / Week	3
CIE	50 Marks	SEE	50 Marks
		Total Hours	40

Course Objective: Students will be able to apply the data science process to real-time data.
Course Outcomes (COs): Upon completion of the course, students shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	Describe the basic concepts of data science	1	-
2.	Apply different techniques for EDA using the R tool	2, 5	-
3.	Apply supervised and unsupervised algorithms for a given problem	3, 4	2
4.	Use data visualization tools and plot graphs.	5, 9	1

Course Contents:

MODULE – 1 **10 Hrs**

Introduction: What is Data Science? Big Data and Data Science hype - and getting past the hype,Why now? –Datafication, Current landscape of perspectives, Skill sets needed.
Statistical Inference - Populations and samples, Statistical modelling, probability distributions, fitting a model.

Demonstration:

1. R-Installation and basics.
2. Construct a dataset of students' grades, attendance, and extracurricular involvement. Use R to perform statistical tests and visualizations to analyze the impact of attendance on academic performance.

MODULE – 2 **10 Hrs**

Exploratory Data Analysis and the Data Science Process - Basic tools (plots, graphs and summary statistics) of EDA, Philosophy of EDA.
The Data Science Process, Case Study: RealDirect (online real estate firm). Three Basic Machine Learning Algorithms - Linear Regression.

Demonstration:

3. Import a .csv file and perform various Exploratory Data Analysis and Data Visualization techniques such as Box plot, Histogram, pie charts and bar charts using R Programming.
4. Design and implement a linear regression model using the iris dataset to predict sepal length. Include variable selection, model training, evaluation, and visual representation of the results. Justify the insights gained from the analysis.

MODULE – 3 **10 Hrs**

k-Nearest, Neighbors (k-NN), k-means. One More Machine Learning Algorithm and Usage in Applications -Motivating application: Filtering Spam, Why Linear Regression and k-NN are poor choices for Filtering Spam, Naive Bayes and why it works for Filtering Spam Data Wrangling: APIs and other tools for scrapping the Web.

Demonstration:

5. Design an R script to calculate and visualize correlation and covariance between variables in a self-constructed dataset. Interpret your findings and suggest data-driven decisions based on the results.
6. Using the `iris` dataset, build a KNN classification model in R to predict flower species based on their measurements. Analyze how varying the value of *k* affects model accuracy.
7. Develop an R program to apply the K-means clustering algorithm for data analysis. Demonstrate the process of selecting the appropriate number of clusters, executing the algorithm, and interpreting the clustering results.

8. Design and implement a Naïve Bayes classifier in a R programming language to classify a sample dataset stored in a .CSV file. After training the model, evaluate its accuracy by testing it on a separate set of test data. Analyze the classifier's performance and interpret the results.

MODULE – 4	**10 Hrs**

Recommendation Systems: Building a User-Facing Data Product - Algorithmic ingredients of a Recommendation Engine, Dimensionality Reduction, Singular Value Decomposition, Principal Component Analysis, Exercise: build your own recommendation system.
Data Visualization - Data Visualization History, What Is Data Science, Redux?, A Sample of Data Visualization Projects.

Text Book :

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Doing Data Science, Straight Talk from The Frontline	Cathy O'Neil and Rachel Schutt		O'Reilly	2014

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Mining of Massive Datasets	Jure Leskovek, Anand Rajaraman and Jeffery Ullman	V2.1	Cambridge University Press	2004
2.	Machine Learning: A Probabilistic Perspective	Kevin P. Murphy	ISBN 0262018 020		2013

MOOCs:

1. Introduction to data Analytics nptel.ac.in/courses/110106064/E-Books: a) An Introduction to Data Science. By J. Stanton, 2013.
2. Data Sciencehttps://drive.google.com/file/d/0B6iefdnF22XQeVZDSkxjZ0Z5VUE/edit

Proposed Assessment Plan (for 50 marks of CIE):

Tool		Remarks	Marks
CIE	CIE-1	Conducted for 20 marks(Module 1) & reduced to 10 marks	10
	CIE-2	Conducted for 20 marks(Module 2) & reduced to 10 marks	10
	CIE-3	Conducted for 20 marks(Module 3) & reduced to 10 marks	10
Activity Details	Act	Project Based activity	20

Course Articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	3	-	-	-	-	-	-	-	-	-
CO3	-	-	3	2	-	-	-	-	-	-	-	-	-	3
CO4	-	-	-	-	2	-	-	-	2	-	-	-	3	-

Course Title	MOBILE COMMUNICATIONS		
Course Code	22CS773	(L-T-P) C	(3-0-0)3
Exam. Hours	3	Hours / Week	3
CIE	50 Marks	SEE	50 Marks
		Total Hours	40

Course Objective: To build real time applications by deploying Mobile Communication technologies.

Course Outcomes (COs) : Upon completion of the course, students shall be able to :

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	Explore the applications, marketing and reference model of Mobile communication system.	1,2,12	-
2.	Classify the different types of transmissions, medium access control techniques and satellite Systems.	1,2	-
3.	Develop the suitable wireless and/or mobile network for a given scenario.	3	1,2
4.	Study the performance of protocols involved in mobile network layer, mobile ad-hoc networks and transport layer.	2,4	-

Course Contents:

MODULE – 1	10 Hrs

Introduction to Mobile Communications: Applications, History of Wireless Communication, A Market for Mobile Communications, Some open research Topics, A simplified reference model.
Wireless Transmission: Frequencies for Radio Transmission, Signals, Antennas, Signal Propagation, Multiplexing, Modulation, Cellular Systems.

MODULE – 2	10 Hrs

Medium Access Control: Motivation for a specialized MAC, TDMA, CDMA, Comparison of S/T/F/CDMA. **Satellite Systems:** History, Applications, Basics, Routing, Localizations, Handover; **Broadcast Systems:** Overview, Cyclical Repetition of data, DAB, DVB, Convergence of Broadcasting and Mobile communications.

MODULE – 3	10 Hrs

Wireless LAN: Infrared versus radio transmission, Infrastructure and Adhoc Network, IEEE-802.11-System Architecture and Protocol Architecture.
Mobile Network Layer: Mobile IP: Goals, assumptions and requirements, Entities and terminology, IP packet delivery, Agent discovery, Registration, Tunnelling and encapsulation, Optimizations; Dynamic host configuration protocol

MODULE – 4	10 Hrs

Mobile ad-hoc networks: Routing, Destination sequence distance vector, Dynamic source routing, Alternative metrics , Overview ad-hoc routing protocols
Mobile Transport Layer: Traditional TCP, Classical TCP improvements, TCP over 2.5/3G wireless networks, Performance enhancing proxies.

Text Book :

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Mobile communications	Jochen Schiller	2nd	Pearson Education	

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year

1.	Mobile Computing – Technology, Applications and ServiceCreation	Asoke K. Talkukder, Roopa R Yavagal		Tata McGraw Hill	2012
2.	Mobile Computing Principles – Designing and Developing Mobile Applications withUML and XML	Reza B'Far	5th	Cambridge University press	2013

Proposed Assessment Plan (for 50 marks of CIE):

Tool		Remarks	Marks
CIE	CIE-I	Conducted for 20 marks(Module 1) & reduced to 10 marks	10
	CIE-II	Conducted for 20 marks(Module 2) & reduced to 10 marks	10
	CIE-III	Conducted for 20 marks(Module 3) & reduced to 10 marks	10
Activity Details	Activity	Designing a Protocol using Network Simulation and Problem solving assignment.	20

Course Articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-		2	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	3	-	-	-	-	-	-	-	-	-	2	2
CO4	-	3	-	2	-	-	-	-	-	-	-	-	-	-

Course Title	SOFTWARE TESTING		
Course Code	22CS774	L-T-P-C	(3-0-0)3
Exam Hrs.	3	Hours/Week	3
SEE	50 Marks	CIE	50 Marks
		Total Hours	40

Course Objective: Apply effective testing techniques for developing quality software products.
Course Outcomes(COs): Upon the completion of the course the students will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	Explore the concepts of software testing and its documentation.	1,2	-
2.	Analyze various software testing methods and strategies	2,3	2
3.	Apply suitable test case generation techniques	3,5	2

Course Contents:

MODULE–1	10Hrs

Basics of Software Testing: Human Errors and Testing; Software Quality; Requirements, Behavior and Correctness; Correctness versus Reliability; Testing and Debugging; Test Metrics.
Software and Hardware Testing; Testing and Verification; Defect Management; Execution History; Test-generation Strategies, Static Testing. Model-Based Testing and Model Checking; Control-Flow Graph; Types of Testing; The Saturation Effect.

MODULE–2	10Hrs

Test Generation from Requirements: Introduction; The Test-Selection Problem; Equivalence Partitioning; Boundary Value Analysis; Category-Partition Method.
Test Generation from Requirements: Cause-Effect Graphing, Test Generation from Predicates.

MODULE–3	10Hrs

Structural Testing: Overview; Statement testing; Branch testing; Condition testing, Path testing; Procedure call testing; Comparing structural testing criteria; The infeasibility problem.
Dependence, Data Flow Models, and Data Flow Testing: Definition-Use pairs; Data flow analysis; Classic analyses; From execution to conservative flow analysis; Data flow analysis with arrays and pointers; Inter-procedural analysis; Overview of data flow testing; Definition-Use associations; Data flow testing criteria; Data flow coverage with complex structures; The infeasibility problem.

MODULE–4	10Hrs

Test Case Selection and Adequacy, Test Execution: Overview; Test specification and cases; Adequacy criteria; Comparing criteria; Overview of test execution; From test case specification to test cases; Scaffolding; Generic versus specific scaffolding; Test oracles; Self-checks as oracles; Capture and replay. Process: Test and analysis activities within a software process: The quality process; Planning and monitoring; Quality goals; Dependability properties; Analysis; Testing; Improving the process; Organizational factors. Integration and component-based software testing: Overview; Integration testing strategies; Testing components and assemblies. System, Acceptance and Regression Testing:
Overview; System testing; Acceptance testing; Usability; Regression testing; Regression test selection techniques; Test case prioritization and selective execution.

Text Book :

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Foundations of Software Testing (Chapters 1 excluding 1.15, 1.16, 1.17, 2, 6).	Aditya P Mathur		Pearson Education	2014

2.	Software Testing and Analysis – Process, Principles and Techniques (Chapters 4, 6, 9, 12, 13, 17, 21, 22).	Mauro Pezze, Michal Young		John Wiley & Sons	2008

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Software testing Principles and Practices	Srinivasan Desikan, Gopalaswamy Ramesh	2nd	Pearson	2007
2.	Software Testing	Ron Patton	2nd	Pearson	2004

MOOC:
http://nptel.ac.in/courses/106105150

Proposed Assessment Plan (for 50 marks of CIE):

Tool		Remarks	Marks
CIE	CIE	Conducted for 20 marks(Module 1) & reduced to 10 marks	10
	CIE	Conducted for 20 marks(Module 2) & reduced to 10 marks	10
	CIE	Conducted for 20 marks(Module 3) & reduced to 10 marks	10
Activity Details		Design a test case for various web and desktop applications	20

Course Articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	2	3	-	-	-	-	-	-	-	-	-	-	2
CO3	-	-	3	-	3	-	-	-		-	-	-	-	3

PATTERN RECOGNITION				
Course Code	**22CS781**		**L-T-P-C**	**(3-0-0)3**
Exam Hours	**3**		**Hours / Week**	**3**
CIE	**50 Marks**		**SEE**	**50 Marks**
			Total Hours	**40**

Course Objective : Apply pattern recognition techniques to real world problems.

Course Outcomes (COs) : Upon completion of the course, students shall be able to:

COs	Statement	POs	PSOs
1.	Describe the fundamental concepts of pattern recognition systems and their applications.	1	-
2.	Explain various classification and decision-making techniques.	1	-
3.	Implementation of pattern recognition techniques	3	2

Course Contents:

Module 1 — **10 Hrs**

Introduction: Machine perception, an example; Pattern Recognition System; The Design Cycle; Learning and Adaptation.

Bayesian Decision Theory: Introduction, Bayesian Decision Theory; Continuous Features, Minimum error rate, classification, classifiers, discriminate functions, and decision surfaces; The normal density; Discriminant functions for the normal density.

Module 2 — **10 Hrs**

Maximum-likelihood and Bayesian Parameter Estimation: Introduction; Maximum-likelihood estimation; Bayesian Estimation; Bayesian parameter estimation: Gaussian Case, general theory; Hidden Markov Models.

Non-parametric Techniques: Introduction; Density Estimation; Parzen windows; kn – Nearest-Neighbor Estimation; The Nearest- Neighbor Rule; Metrics and Nearest-Neighbor Classification.

Module 3 — **10 Hrs**

Linear Discriminant Functions: Introduction; Linear Discriminant Functions and Decision Surfaces; Generalized Linear Discriminant Functions; The Two-Category Linearly Separable case; Minimizing the Perception Criterion Functions; Relaxation Procedures; Non-separable Behavior; Minimum Squared-Error procedures; The Ho-Kashyap procedures.

Stochastic Methods: Introduction; Stochastic Search; Boltzmann Learning; Boltzmann Networks and Graphical Models; Evolutionary Methods.

Module 4 — **10 Hrs**

Non-Metric Methods: Introduction; Decision Trees; CART; Other Tree Methods; Recognition with Strings; Grammatical Methods.

Unsupervised Learning and Clustering: Introduction; Mixture Densities and Identifiability; Maximum-Likelihood Estimates; Application to Normal Mixtures; Unsupervised Bayesian Learning; Data Description and Clustering; Criterion Functions for Clustering.

Text Book :

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Pattern Classification	Richard O. Duda, Peter E. Hart, and David G.Stork	2nd	Wiley-Interscience	2012

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Pattern Recognition and Image Analysis	Earl Gose, Richard Johnsonbaugh, Steve Jost		Pearson Education	**2007**

Activity:

1.	Develop a Bayesian classifier to predict whether a patient is likely to have a particular disease based on observed symptoms and historical data.
2.	Develop a K-Nearest Neighbor (KNN) classifier to predict whether a customer will buy a product based on their demographic information and past purchasing behavior
3.	Design a Linear Discriminant Function to classify emails as 'Spam' or 'Not Spam' based on extracted textual features
4.	Apply stochastic methods to optimize the scheduling of tasks in a smart factory to minimize production time and resource conflicts
5.	Build a Decision Tree model to predict whether a loan application should be approved based on applicant details such as income, credit history, employment status, and existing debts
6.	Estimate the parameters of a Gaussian distribution to model and predict student test scores using Maximum Likelihood Estimation

Proposed Assessment Plan (for 50 marks of CIE):

Tool		Remarks	Marks
CIE	CIE	Conducted for 20 marks and reduced to 10 marks	10
	CIE	Conducted for 20 marks and reduced to 10 marks	10
	CIE	Conducted for 20 marks and reduced to 10 marks	10
Activity Details		Demonstration concepts will be evaluated as activity	20

Course Articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-		-	-
CO2	3	-	-	-	-	-	-	-	-	-	-		-	-
CO3	-	-	3	-	-	-	-	-	-	-	-		-	2

Course Title	BIG DATA ANALYTICS		
Course Code	22CS782	L-T-P-C	(3-0-0)3
Exam Hrs.	3	Hours/Week	3
CIE	50 Marks	SEE	50 Marks
		Total Hours	40

Course Objective: Introduce Big Data technologies for solving the real world problems

Course Outcomes(Cos): Upon completion of the course the students will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	Describe the basic concepts of Big Data and Big data analytics	1	-
2.	Apply Big data framework for data analysis	2,3	1
3.	Use Big data tools and techniques in processing the data	3,5	1,2

Course Contents:

MODULE – 1 **10Hrs**

Introduction to Big Data: Types of Digital Data**,** Characteristics, Evolution and definition of Big data, What is Big data, Why Big data, Traditional Business Intelligence Vs Big Data, Typical data warehouse and Hadoop environment.

Big Data Analytics: What is Big data Analytics, Classification of Analytics, Importance of Big Data Analytics, Technologies used in Big data Environments

Demonstration: Working on varieties of Data and their representations

MODULE – 2 **10Hrs**

Introduction to Hadoop: Introducing hadoop, Why hadoop, Why not RDBMS, RDBMS Vs Hadoop, History of Hadoop, Hadoop overview, HDFS (Hadoop Distributed File System), Processing data with Hadoop, Interacting With Hadoop Ecosystsem.

Demonstration: Install Hadoop and Implement the file management tasks in Hadoop: Adding files and directories Retrieving files Deleting files and directories.

MODULE – 3 **10Hrs**

Introduction to Map Reduce Programming: Introduction, Mapper, Reducer, Combiner, Partitioner, Searching, Sorting, Compression.

Introduction to MongoDB: What is MongoDB? Why MongoDB, Terms Used in RDBMS and MangoDB, Data Types in MangoDB, MangoDB Query Language

Demonstration: Application of Map Reduce to various scenarios

MODULE – 4 **10Hrs**

Introduction To HIVE: What is Hive?, HIVE Architecture, HIVE Data Types, HIVE File Format, HIVE Query Language, User Defined Functions

Introduction TO PIG: What is PIG? The Anatomy of PIG, PIG on Hadoop, PIG Philosophy, Use Case for PIG – ETL Processing, PIG Latin Overview, Data Types in PIG, Execution Modes of PIG, Relational Operators, User Defined Functions, Word Count Example Using PIG.

Demonstration: Working with PIG and HIVE

Text Book :

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Big data and Analytics	Seema Acharya and Subhashini Chellappan	2nd	Wiley India	2019

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Big Data Imperatives	Soumendra Mohanty, Madhu Jagadeesh, Harsha Srivatsa	1st	A press	2012
2.	Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Business	Michael Minelli, Michehe Chambers	1st	Wiely CIO Series	2013
3.	Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics	Bill Franks	1st	Wiley and SAS Business Series	2012

MOOC:
https://nptel.ac.in/courses/106/104/106104189

Proposed Assessment Plan (for 50 marks of CIE):

Tool		Remarks	Marks
CIE	CIE	Conducted for 20 marks and reduced to 10 marks	10
	CIE	Conducted for 20 marks and reduced to 10 marks	10
	CIE	Conducted for 20 marks and reduced to 10 marks	10
Activity Details		Demonstration concepts will be evaluated as activity	20

Course Articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	2	-	-	-	-	-	-	-	-	-	-	3
CO3	-	-	3	-	3	-	-	-	-	-	-	-	-	2

Course Title	CLOUD COMPUTING		
Course Code	22CS783	L-T-P-C	(3-0-0) 3
Exam Hrs.	3	Hours/Week	3
CIE	50Marks	SEE	50 Marks
		Total Hours	40

Course Objective: To expose students to frontier areas of cloud computing service models and applications.

Course Outcomes (COs): Upon completion of the course, students shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	Explore different cloud computing delivery models and services	1,7	-
2.	Analyse various cloud computing resource management and virtualization techniques.	2,3	-
3.	Integrate new standards for access management, security and privacy at different levels of cloud services.	3, 6	
4.	Demonstrate the usage of various cloud computing platforms and resources.	5, 12	1, 2

Course Contents:

MODULE–1 **10Hrs**

Introduction: Cloud computing: An old idea whose time has come, Cloud computing delivery models and services, Ethical issues in cloud computing, Cloud vulnerabilities, Major challenges faced by cloud computing. **Cloud Infrastructure:** Cloud computing at Amazon, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Open-source software platforms for private clouds, Cloud storage diversity and vendor lock in, Energy use and ecological impact of Large-Scale Data Centres, Service- and Compliance level agreements, User experience and software licensing.

MODULE–2 **10Hrs**

Cloud Computing: Applications and Paradigms: Challenges of cloud computing, Architectural styles for cloud applications, Workflows: Coordination of multiple activities, Coordination based on a state machine model: The Zookeeper, The Map Reduce programming model, Clouds for science and engineering, High-performance computing on a cloud, Cloud computing for Biology research, social computing, Digital Content, and Cloud Computing.

MODULE–3 **10Hrs**

Cloud Resource Virtualization: Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and paravirtualization, Hardware support for virtualization. **Cloud Resource Management and Scheduling**: Policies and mechanisms for resource management, Application of control theory to task scheduling on a cloud, Resourcing bundling: Combinatorial auctions for cloud resources, Scheduling algorithms for computing clouds, Fair queuing, Start-time fair queuing.

MODULE–4 **10Hrs**

Cloud Security: Cloud security risks, Security: The top concern for cloud users, Privacy and privacy impact assessment, Trust, Operating system security, Virtual machine Security, Security of virtualization, Security risks posed by shared images, Security risks posed by a management OS, A trusted virtual machine monitor. **Cloud Application Development:** Amazon web services: EC2 instances, connecting clients to cloud instances through firewalls, Security rules for application and transport layer protocols in EC2, How to launch an EC2 Linux instance and connect to it, Cloud-based simulation of a distributed trust algorithm.

Text Book :

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Cloud Computing: Theory and Practice	Dan C Marinescu	1st	Elsevier (MK),	2013

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Cloud Computing- A practical approach	Anthony T. Velte, Toby J. Velte, Robert Elsenpeter	1st	McGraw Hill	

MOOCs:

1. https://www.javatpoint.com/cloud-computing-tutorial
2. https://www.tutorialspoint.com/cloud_computing/index.htm
3. https://www.digimat.in/nptel/courses/video/106105167/L01.html (**Video Lectures**)

Proposed Assessment Plan (for 50 marks of CIE):

Tool		Remarks	Marks
CIE	CIE-1	Conducted for 20 marks and reduced to 10 marks	10
	CIE-2	Conducted for 20 marks and reduced to 10 marks	10
	CIE-3	Conducted for 20 marks and reduced to 10 marks	10
Activity Details		Group Activity will be conducted using various cloud platforms	20

Course Articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	2	-	-	-	-	-	-	-
CO2	-	3	2	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	3	-	-	2	-	-	-	-	-	-	-	-
CO4	-	-	-	-	3	-	-	-	-	-		2	2	2

Course Title	GREEN COMPUTING		
Course Code	22CS784	L-T-P-C	(3-0-0)3
Exam Hrs.	3	Hours/Week	3
CIE	50 Marks	SEE	50 Marks
		Total Hours	40

Course Objective: To enable students to design, manufacture, and dispose computing devices in a way that reduces their environmental impact.

Course Outcomes(COs): Upon completion of the course, students shall be able to:

#	Course Outcomes	Mapping to POs	Mappingto PSOs
1.	Explore fundamentals of Green Computing	1,7	-
2.	Analyze various sustainability challenges and strategies that can reduce the environmental impact of usage of computers	2,7	-
3.	Relate the green computing practices to make business more energy efficient and Green compliant.	6,12	-
4.	Document and present the technical paper with proposed sustainable solution for Green Computing.	3,4,7,8,9,10	-

Course Contents:

MODULE – 1 **10 Hrs**

Green IT: An Overview, Introduction, Environmental Concerns and Sustainable Development, Environmental Impacts of IT, Green IT, Holistic Approach to Greening IT, Greening IT, Applying IT for enhancing Environmental sustainability, Green IT Standards and Eco-Labelling of IT, Enterprise Green IT strategy, Green IT: Burden or Opportunity, Green Devices and Hardware: Introduction, Life Cycle of a device or hardware, Reuse, Recycle and Dispose.

Green Software: Introduction, Energy-saving software techniques, Evaluating and Measuring software Impact to platform power. Sustainable Software Development: Introduction, Current Practices, Sustainable Software, Software Sustainability Attributes, Software Sustainability Metrics

MODULE – 2 **10 Hrs**

Green Data Centres: Data Centres and associated energy challenges, Data centre IT infrastructure, Data Centre facility infrastructure: Implications for energy efficiency, IT infrastructure management.

Green Networks and Communications: Introduction, Objectives of Green Network Protocols, Green Network Protocols and Standards. Enterprise Green IT Strategy: Introduction, Approaching Green IT Strategies, Business Drivers of Green IT Strategy, Business Dimensions for Green IT Transformation, Organizational Considerations in a Green IT Strategy, Steps in Developing a Green IT Strategy. Green Enterprises and Role of IT: Introduction, Organization and Enterprise Greening, Information systems in Greening Enterprises, Greening Enterprise: IT Usage and Hardware, Inter-Organizational Enterprise activities and Green Issues.

MODULE – 3 **10 Hrs**

Managing Green IT: Introduction, Strategizing Green Initiatives, Implementation of Green IT, Information Assurance. Regulating Green IT: Laws, Standards and Protocols: Introduction, The regulatory environment and IT manufacturers, Non regulatory government initiatives, Industry associations and standards bodies, Green building standards, Green data centres, Social movements and Greenpeace

Green Cloud Computing and Environmental Sustainability: Introduction, what is Cloud Computing? Cloud Computing and Energy Usage Model: A Typical Example, Features of Clouds Enabling Green Computing, Towards Energy Efficiency of Cloud Computing, Green Cloud Architecture

MODULE – 4 **10 Hrs**

Harnessing Semantic Web Technologies for the Environmental: Introduction, Information Management for Environmental Sustainability, Ecosystem of Software Tools, Examples of Managing Data.

Green IT-An Outlook: Introduction, Awareness to implementations, Greening by IT, Green IT: A megatrend, A seven-step approach to creating green IT strategy, Research and Development directions.

Text Book :

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Harnessing Green IT: Principles and Practices	San Murugesan, G. R. Gangadharan	1st	Wiley& IEEE	2017

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Green IT Strategies and Applications-Using Environmental Intelligence	BhuvanUnhelkar	1st	CRC Press	**2011**
2.	Green Communications: Principles, Concepts and Practice	Konstantinos Samdanis, Peter Rost, Andreas Maeder, Michela Meo, Christos Verikoukis	1st	Wiley	**2015**

Proposed Assessment Plan (for 50 marks of CIE):

Tool		Remarks	Marks
CIE	CIE-1	Conducted for 20 marks and reduced to 10 marks	10
	CIE-2	Conducted for 20 marks and reduced to 10 marks	10
	CIE-3	Conducted for 20 marks and reduced to 10 marks	10
Activity Details		Group based activity	20

Course Articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	3	-	-	-	-	-	-	-
CO2	-	2	-	-	-	-	2	-	-	-	-	-	-	-
CO3	-	-	-	-	-	3	-	-	-	-	-	2	-	-
CO4	-	-	2	2	-	-	2	3	3	3	-	-	-	-

Course Title	INTRODUCTION TO DATA SCIENCE (OPEN ELECTIVE)		
Course Code	22OECS71	L-T-P	(3-0-0)3
Exam	3 Hrs.	Hours/Week	3
CIE	50 Marks	SEE	50 Marks
		Total Hours	40

Course Objective: Introduce major data science approaches and their applications to solve real world problems.

Course Outcomes: At the end of the course, student will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	Comprehend the basic data operations and overview of simple statistical models.	1	-
2.	Apply specific Supervised, and Unsupervised algorithms to obtain solutions for appropriate problems.	3, 5	-
3.	Explore the various Network Analysis and Recommendation Systems real world problems.	3, 5	-

MODULE-1	10 Hrs

Introduction, Toolboxes: Python, fundamental libraries for data Scientists. Integrated development environment (IDE). Data operations: Reading, selecting, filtering, manipulating, sorting, grouping, rearranging, ranking, and plotting.

Descriptive statistics: data preparation. Exploratory Data Analysis data summarization, data distribution, measuring asymmetry. Sample and estimated mean, variance and standard score.

MODULE-2	10 Hrs

Statistical Inference: Statistical Inference frequency approach, variability of estimates, hypothesis testing using confidence intervals, using p-values

Supervised Learning: First step, learning curves, training-validation and test. Learning models generalities, support vector machines, random forest. Examples

MODULE-3	10 Hrs

Regression analysis, Regression: Linear regression simple linear regression, multiple & Polynomial regression, Sparse model.

Unsupervised learning: Introduction, Clustering, similarity and distances, quality measures of clustering, case study.

MODULE-4	10 Hrs

Network Analysis: Basic Definitions in Graphs, Social Network Analysis, Centrality, drawing centrality of Graphs, PageRank, Ego-Networks, Community Detection.

Recommender Systems: Introduction, Works: Content-Based Filtering, Collaborative Filtering, Hybrid Recommenders, Modeling User Preferences, Evaluating Recommenders, Practical Case.

Text Book :

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Introduction to Data Science a Python approach to concepts, Techniques and Applications	Laura Igual and Santi Segui'		Springer, ISBN:978-3-319-50016-4	

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Data Analysis with Python A Modern Approach	David Taieb,	1st	Packt, ISBN-9781789950069	
2.	Python Data Analysis	Armando Fandango	2nd	Packt, ISBN: 9781787127487	

e-Books:

1. https://dokumen.pub/introduction-to-data-science-a-python-approach-to-concepts-techniques-and-applications-9783319500171-3319500171.html

MOOCS

1.https://www.lewagon.com/events/data-science-foundations-free-online-course

2. https://onlinecourses.nptel.ac.in/noc22_cs32/preview

Proposed Assessment Plan (for 50 marks of CIE):

Tool		Remarks	Marks
CIE	CIE-1	Conducted for 20 marks(Module 1) & reduced to 10 marks	10
	CIE-2	Conducted for 20 marks(Module 2) & reduced to 10 marks	10
	CIE-3	Conducted for 20 marks(Module 3) & reduced to 10 marks	10
Activity Details		Project Based Activity	20

Course Articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	3	-	3	-	-	-	-	-	-	-	-	-
CO3	-	-	3	-	3	-	-	-	-	-	-	-	-	-

Course Title	IOT AND ITS APPLICATIONS		
Course Code	22OECS72	L-T-P-C	(3-0-0)3
Exam Hrs.	3	Hours / Week	3
CIE	50 Marks	SEE	50
		Total Hours	40

Course Objective: Explore the interconnection and integration of the physical world and design IOT applications.

Course Outcomes (COs) : Upon the completion of the course the students will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	Describe the fundamental concepts of physical, logical design and domain-specific applications.	1	-
2.	Analyze IoT system management techniques and Machine-to-Machine (M2M) communication	2	-
3.	Design IoT applications using Raspberry Pi.	3,5	-

Course Contents:

MODULE – 1 **10 Hrs**

Introduction & Concepts- Introduction of IoT; Physical Design of IoT; Logical Design of IoT; IoT Enabling Technologies; IoT Levels & Deployment Templates. Domain Specific IoTs- Introduction, Home Automation; Cities; Environment; Energy; Retail; Logistics; Agriculture; Industry; Health & Lifestyle

MODULE – 2 **10 Hrs**

IoT and M2M-Introduction; M2M; Difference between IoT and M2M; SDN and NFV for IoT; IoT System management with NETCONF-YANG- Need for IoT Systems management; SNMP; Network Operator Requirements; NETCONF; YANG; IoT Systems management with NETCONF-YANG; NETOPEER IoT Platforms Design Methodology; Introduction; IoT Design Methodology; Case Study on IoT System for Weather Monitoring; Motivating for using Python.

MODULE – 3 **10 Hrs**

IoT Systems- Logical Design using Python- Introduction; Installing Python; Python Data Types & Data structures; Control Flow; Functions; Modules; Packages; File Handling; Date/Time Operations; Classes. What is an IoT Device; Exemplary Device: Raspberry Pi; About the Board; Linux on Raspberry Pi; Raspberry Pi Interfaces ; Programming Raspberry Pi with Python

MODULE – 4 **10 Hrs**

Case Studies Illustrating IoT: Introduction; Home Automation; Cities; Environment. Environment; Agriculture ; Productivity Applications

Text Book :

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Internet of Things - A Hands-on Approach	Arshdeep Bahga and Vijay Madisetti		Universities Press	2015

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	IoT Fundamentals: Networking Technologies, Protocols,	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry	1st	Pearson Education (Cisco Press Indian Reprint)	

	and Use Cases for the Internet of Things				
2.	Internet of Things	Srinivasa K G, Siddesh G M Hanumantha Raju R	1st	CENGAGE Leaning India	2017
3.	Olivier Hersent, David Boswarthick, Omar Elloumi	The Internet of Things: Key Applications and Protocols	2nd	Wiley ISBN: 978-1-119-99435-0	2012

Proposed Assessment Plan (for 50 marks of CIE):

Tool		Remarks	Marks
CIE	CIE-1	Conducted for 20 marks and reduced to 10 marks	10
	CIE-2	Conducted for 20 marks and reduced to 10 marks	10
	CIE-3	Conducted for 20 marks and reduced to 10 marks	10
Activity Details		Group Based Activity	20

Course Articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	3	-	2	-	-	-	-	-	-	-	-	-

Course Title	INTRODUCTION TO BIG DATA		
Course Code	22OECS73	L-T-P-C	(3-0-0)3
Exam Hrs.	3	Hours/Week	3
CIE	50 Marks	SEE	50 Marks
		Total Hours	40

Course Objective: Acquire the knowledge to handle Big Data.

Course Outcomes(COs): Upon completion of the course the students will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	Describe basic Concepts of Big data Analytics	1	-
2.	Apply Big data framework for data analysis	2,3	-
3.	Use Big Data tools and techniques in processing of data	3,5	-

Course Contents:

MODULE–1 **10Hrs**

Introduction: Velocity, Variety, Veracity; Drivers for Big Data, Sophisticated Consumers, Automation, Monetization.

Big Data Analytics Applications: Social Media Command Center, Product Knowledge Hub, Infrastructure and Operations Studies, Product Selection, Design and Engineering, Location-Based Services, Online Advertising, Risk Management.

MODULE–2 **10Hrs**

Architecture Components: Massively Parallel Processing (MPP) Platforms, Unstructured Data Analytics and Reporting: Search and Count, Context-Sensitive and Domain-Specific Searches, Categories and Ontology, Qualitative Comparisons, Data Privacy Protection, Real-Time Adaptive Analytics and Decision Engines.

Advanced Analytics Platform: Real-Time Architecture for Conversations, Orchestration and Synthesis Using Analytics Engines, Entity Resolution, Model Management, Discovery Using Data at Rest, Integration Strategies.

MODULE–3 **10Hrs**

Implementation of Big Data Analytics: Revolutionary, Evolutionary, or Hybrid, Big Data Governance, Integrating Big Data with MDM, Evolving Maturity Levels.

Map-Reduce and the New Software Stack: Distributed File Systems. Physical Organization of Compute Nodes, Large-Scale File-System Organization, Map-Reduce features: Map Tasks, Grouping by Key, Reduce Tasks, Combiners, Map-Reduce Execution, Coping With Node Failures.

MODULE–4 **10Hrs**

Communication Cost Models: Complexity Theory for Map-Reduce, Reducer Size and Replication Rate, Graph Model and Mapping Schemas, Lower Bounds on Replication Rate.

Mining Data Streams, Stream Data Mode l and Management Stream Source, Stream Queries, and issues, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Estimating Moments, Counting Ones in a Window, Decaying Windows.

Text Book :

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Big Data Analytics: Disruptive Technologies for Changing the Game	Dr. Arvind Sathi	1st	IBM Corporation	2012

2.	Mining of Massive Datasets	Anand Rajarama, Jure Leskovec, Jeffrey D. Ullman	1st	E-book	2013

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Big Data Imperatives	Soumendra Mohanty, Madhu Jagadeesh, Harsha Srivatsa,	1st	A press, e-book	2012
2.	Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Business	Michael Minelli, Michehe Chambers, Ambiga Dhiraj	1st	Wiely CIO Series	2013
3.	Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics	Bill Franks	1st	Wiley and SAS Business Series	2012
4.	Big Data Imperatives	Soumendra Mohanty, Madhu Jagadeesh, Harsha Srivatsa	1st	Apress, e-book	2012

MOOC:

https://nptel.ac.in/courses/106/104/106104189

Proposed Assessment Plan (for 50 marks of CIE):

Tool		Remarks	Marks
CIE	CIE-1	Conducted for 20 marks and reduced to 10 marks	10
	CIE-2	Conducted for 20 marks and reduced to 10 marks	10
	CIE-3	Conducted for 20 marks and reduced to 10 marks	10
Activity Details		Project based activity	20

Course Articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	2	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	3	-	3	-	-	-	-	-	-	-	-	-

Course Title	PROFESSIONAL ELECTIVE THROUGH NPTEL		
Course Code	**22SW01**	**L-T-P-C**	**(3-0-0)3**
Course Objective: To promote self-learning ability.			
Guideline: Students must register for one course from the bucket of courses announced by the department in Swayam NPTEL portal. The selected course must be a 12-week, 3-credit course. There will be direct credit transfer of 3 credits. Students are permitted to complete this course anytime between their second to fourth year of the program. The result will be entered in eighth semester grade card.			

Course Title	PROFESSIONAL ELECTIVE THROUGH NPTEL		
Course Code	**22SW02**	**L-T-P-C**	**(3-0-0)3**
Course Objective: To promote self-learning ability.			
Guideline: Students must register for one course from the bucket of courses announced by the department in Swayam NPTEL portal. The selected course must be a 12-week, 3-credit course. There will be direct credit transfer of 3 credits. Students are permitted to complete this course anytime between their second to fourth year of the program. The result will be entered in eighth semester grade card.			

Course Title	RESEARCH / INDUSTRY INTERNSHIP - III		
Course Code	22INT3	L-T-P-C	(0-0-24)10
Exam Hrs.	3	Hours / Week	-
CIE	100 Marks	Total Hours	-

Course Objective: To gain the perspective of work environment in Research organization/Industry or Complete MOOC Courses contributing to technical skill enhancement.

Course Outcomes (COs): Upon completion of the course, students shall be able to:

#	Course Outcomes	Mapping to POs	Mappingto PSOs
1.	Apply the domain knowledge in solving the real world problems.	1,2	1,2
2.	Work as a team member towards the chosen problem	9	1,2
3.	Work with industry professionals and practice ethics in work environment.	8, 10	1,2
4.	Document, publish and present the work carried out.	9,10,11	1,2

The Internship work is to be evaluated in two stages:

Phase I (50M) - First internal evaluation shall be taken up during this phase. This includes Topic Relevance, Application of Technology and Weekly Report (Dairy) & Presentation.

Phase II (50 M) – Mid phase evaluation shall be taken up during this phase. This includes presentation, Internship Report, Update of the work dairy, Demonstration or Working Methodology (Write-up).

Guideline: Students shall undergo In-house/ Research organization/Industry internship for a duration of **one** semester. Internal evaluation will be conducted in the phase manner according to the schedule announced at the beginning of the semester.

Phase I Evaluation Rubrics for Industry/Research Internship (50 Marks Total)

Includes: Topic Relevance, Application of Technology, Weekly Report (Diary), Presentation

Criteria	Excellent	Good	Average	Poor
Ability to apply domain knowledge (20M)	16-20	11-15	6-10	0-5
Ability to demonstrate effective oral and written communication skills (10M)	8-10	6-7	3-5	0-2
Presentation & Weekly Report (10M)	8-10	6-7	3-5	0-2
Ethical behavior and integrity (10M)	8-10	6-7	3-5	0-2

Phase II Evaluation Rubrics for Industry/Research Internship (50 Marks Total)

Includes: Presentation, Internship Report, Updated Work Diary, Demonstration/Working Methodology

Criteria	Excellent	Good	Average	Poor
Ability to develop/implement solutions with appropriate techniques (20M)	16-20	11-15	6-10	0-5
Ability to work independently and in collaboration/multidisciplinary environment (10M)	8-10	6-7	3-5	0-2
Time management and task completion (10M)	8-10	6-7	3-5	0-2
Prototype of the Internship Project/Research Paper Presentation (10M)	8-10	6-7	3-5	0-2

OR

FOUR MOOC Courses offered by VTU should be completed.

Proposed Assessment Plan (for 100 marks of CIE):

Tool		Remarks	Marks
CIE	Phase-1	Conducted for 50 marks based on above 4 criteria	50
	Phase-2	Conducted for 50 marks based on above 4 criteria	50

Course Articulation matrix														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	2
CO2	-	-	-	-	-	-	-	-	3	-	-	-	3	2
CO3	-	-	-	-	-	-	-	3	-	3	-	-	3	2
CO4	-	-	-	-	-	-	-	-	3	3	3	-	3	2