Scheme of

B. Tech. in CSE (Artificial Intelligence & Machine Learning)

Year	Semester	Course Code	Course Name	Type	L	T	P	Credits
FIRST YEAR								
1ST	1ST	MAL105	Calculus for Data Science	BS	3	1	0	4
1ST	1ST	CSL110	Conversational AI	DC	2	0	2	3
1ST	1ST	CSL101	Computer Programming	DC	3	0	2	4
1ST	1ST	CSL111	AI, Ethics and Society	DC	2	0	0	2
1ST	1ST	ECL103	Applied Electronics	ES	3	0	2	4
1ST	1ST	HUL102	Environmental Studies	HU	2	0	0	0
1ST	1ST	SAP101	Health, Sports & Safety	HU	0	0	2	0
			Subtotal		**15**	**1**	**8**	**17**
1ST	2nd	MAL106	Probability and Statistics	BS	3	1	0	4
1ST	2nd	MAL107	Introduction to Linear Algebra	BS	3	1	0	4
1ST	2nd	CSL102	Data Structures	DC	3	0	2	4
1ST	2nd	CSL103	Application Programming	DC	3	0	2	4
1ST	2nd	HUL 101	Communication Skills	HU	2	0	2	3
1ST	2nd	CSP201	IT Workshop - I	DC	0	0	4	2
			Subtotal		**14**	**2**	**10**	**21**
				Total				**38**
SECOND YEAR								
2nd	3rd	CSL202	Introduction to Object Oriented Programming	DC	3	0	2	4
2nd	3rd	CSL210	Data Structure with Applications	DC	2	0	2	3
2nd	3rd	CSL204	Discrete Maths and Graph Theory	DC	3	1	0	4
2nd	3rd	CSL216	Foundations of Computing	DC	3	0	0	3
2nd	3rd	CSL203	Computer System Organization	DC	3	0	0	3
2nd	3rd	HUL103	Introduction to Entrepreneurship	HU	3	0	0	3
2nd	3rd	CSP203	AI/ML Workshop-I	DC	0	0	4	2
			Subtotal		**12**	**1**	**10**	**21**
2nd	4th	CSL422	Machine Learning	DC	3	0	2	4
2nd	4th	CSL205	Design and Analysis of Algorithms	DC	3	0	2	4
2nd	4th	CSL206	Software Engineering	DC	3	0	0	3
2nd	4th	CSL207	Operating Systems	DC	3	0	2	4
2nd	4th	CSL301	Database Management Systems	DC	3	0	2	4
2nd	4th	CSL214	Data Handling and Visualization	DC	1	0	2	2
2nd	4th	CSP204	AI/ML Workshop – II	DC	0	0	4	2
			Subtotal		**18**	**0**	**12**	**24**
			Total					**45**
THIRD YEAR								
3rd	5th	CSL421	Artificial Intelligence	DC	3	0	2	4
3rd	5th	CSL433	Natural Language Processing	DC	3	0	2	4
3rd	5th	CSL308	Computer Vision Techniques	DC	3	0	2	4
3rd	5th	CSL315	Computer Networks & Internet	DC	3	0	0	3
3rd	5th		Open Course –I	OC	3	0	0	3
3rd	5th	CSD301	Mini Project – I	DE	0	0	6	3
			Subtotal		**15**	**0**	**14**	**21**
3rd	6th	CSL316	Reinforcement Learning	DC	3	0	2	4

		CSL446	Neural Network & Deep Learning	DC	3	0	0	3
3rd	6th	CSL317	Parallel and Distributed Computing	DC	3	0	0	3
3rd	6th		Open Course – II	OC	3	0	0	3
3rd	6th	CSL318	Optimization Techniques in ML	DC	3	0	0	3
3rd	6th	CSD302	Mini Project-II	DE	0	0	6	3
			Subtotal		**15**	**0**	**8**	**19**
			Total					**40**
			FINAL YEAR					
4th	7th		Elective – I	DE	3	0	0	3
4th	7th		Elective – II	DE	3	0	2	4
4th	7th		Elective –III	DE	3	0	0	3
4th	7th		Elective -IV	DE	3	0	0	3
4th	7th		MooC Course / Open Course – III	OC	3	0	0	3
4th	7th	CSD 403	Project Phase – I	DE	0	0	4	2
			OR					
4th	7th	CSD 402	Industry Internship Project	DE	**0**	**0**	**12**	**6**
4th	7th	CSD 403	Project Phase – I	DE	**0**	**0**	**4**	**2**
			Subtotal		**15/0**	**0**	**6/16**	**18 / 8**
			Total					
4th	8th		Elective – I	DE	3	0	0	3
4th	8th		Elective – II	DE	3	0	2	4
4th	8th		Elective –III	DE	3	0	0	3
4th	8th		Elective -IV	DE	3	0	0	3
4th	8th		MooC Course / Open Course – III	OC	3	0	0	3
4th	8th	CSD 404	Project Phase – II	DE	0	0	12	6
			OR					
4th	8th	CSD 402	Industry Internship Project	DE	**0**	**0**	**12**	**6**
4th	8th	CSD 404	Project Phase - II	DE	**0**	**0**	**12**	**6**
			Subtotal		**0/15**	**0**	**24/14**	**12/23**
				Total				**31**
			GRAND TOTAL					**153**

TYPE	CREDITS
BS	12
ES	04
HU	06
OC	09
DE	33
DC	89
Total	**153**

1st Year Syllabus

Course Code	MAL105	Course Title	Calculus for Data Science			
Category	Core	Credit Assigned	L	T	P	C
			3	1	0	4
Pre-requisite (If any)	-	Type of Course	Basic Science			

Course Outcomes:

1) To analyze the nature (convergence or divergence) of a sequence or series.
2) To apply mean value theorems in the study of motion of an object.
3) To use integration in the calculation of area, volume, mass, and centre of gravity.
4) To apply multivariable calculus to study the nature of multivariable functions.
5) To understand the concept of Differential equation and its application

Course Contents:

Module 1:

Sequences and series: Sequences of real numbers, Series, ratio and root test.

Module 2:

Calculus of functions of single variable: Review of limits, continuity, and differentiability. Mean value theorems: Rolle's theorem, Lagrange's theorem, Cauchy's theorem, Taylor's theorem with remainders, indeterminate forms, curvature, curve tracing. Fundamental theorem of Integral calculus, mean value theorems of integral calculus, evaluation of definite integrals, applications in area, length, volumes and surface of solids of revolutions, Improper integrals: Beta and Gamma functions, differentiation under integral sign.

Module 3:

Calculus of Functions of Several Variables: Limit, continuity and differentiability of functions of several variables, partial derivatives and their geometrical interpretation, Tangent plane and normal line. Total differentiation, chain rules, Taylor's formula, maxima and minima, Lagrange's method of undetermined multipliers. Double and triple integrals, Jacobian, change of order of integration, change of variables, application to area, volumes, Mass, Centre of gravity.

Module 4:

Differential equation and its modelling with curve fitting: Modelling with Differential Equations , Direction Fields and Euler's Method , Linear and Bernoulli's differential equations, Nonlinear differential equations, Polar curves, angle between the radius vector and the tangent, angle between two curves. Pedal equations. Curvature and Radius of curvature - Cartesian, Parametric, Polar and Pedal forms. Problems Canter and circle of curvature, evolutes and involutes.

Text Books:

1. Kreyszig, E., Advanced Engineering Mathematics, John Wiley & Sons

Reference Books:

1. Piskunov, N., Differential and Integral calculus, Mir publishers Moscow (Vol. 1, Vol. 2)

Course Code	CSL110	Course Title	Conversational Artificial Intelligence			
Category	Core	Credit Assigned	L	T	P	C
			1	0	2	2
Pre-requisite (If any)	-	Type of Course	Computer Science and Engineering			

Course Outcomes:

- Students will understand the concepts of chatbot designing
- Students will be able to build their own chatbots

- Students will be able to deploy chatbot for its practical use

Course Contents:

Module 1:
Conversational Design Process: Introduction to virtual assistant/chatbot, use cases, what is conversational design, conversational design process, designing conversational flows, writing the script, designing your conversations, Introduction to Dialogflow, Setting up Dialogflow

Module 2:
Building blocks of Interaction models: Agents, types of Intents, creating Intents, training phrases, Entities, configuring rich responses, small talk and salutations, Configuring and testing Intents on Google Assistant, Working on Connected Flows.

Module 3:
Linear and Non-linear dialogue: Actions & Parameters, understanding slot filling, context, extended Lead Generation, linear dialogue, nonlinear Dialogue, webhook, Fulfilment.

Module 4 :
Fulfilment: Fulfilment using webhook, basic setup of webhook code, Extracting parameter values and structuring responses, fulfilment using cloud function

Module 5:
Deployment: Introduction to Heroku**,** Deploying to Heroku, Deploying on Alexa, Re-training , Validation & Testing.

Text Books:

1. Hands-on chatbot with Google Dialogflow, Loonycorn, O'Reilly, Packt publishing
2. Hands-on chatbots and conversational UI development, Srini Janarthanam, Packt publishing

Course Code:	**CSL111**	**Course Title:**	**AI, Ethics, and Society**
Category:	**Core**	**Credit Assigned**	**L** **T** **P** **C** **2** **0** **0** **2**
Pre-Requisite (if Any)	**Nil**	**Type of Course**	**Computer Science and Engineering**

Course Outcomes:
After successfully completion of the course, Students shall be able to

1. To understand the power and impact that analytics and AI/ML have on individuals and society.
2. To understand the underlying components of big data
3. To understand and apply basic AI/ML techniques to data scenarios, with a focus on identifying fairness and bias issues.
4. To utilize tools and methods to quantify bias and examine ways to use algorithmic fairness to mitigate this bias.

Course Contents:
Module 1 - Data, Individuals, and Society
Power and impact of analytics and AI/ML on individuals and society, fairness and bias, ethics, legality, data collection and public use.

Module 2 – The foundation of Big Data
Various components of big data, statistical techniques to data scenarios, issues in learning from big data, ranging from data biases, overfitting, causation vs correlation.

Module 3 – Fairness in AI/ML
Basic AI/ML techniques for data handling, identification of fairness and bias, issues in the design of decision-making systems, Fairness and bias in the social and legal context of facial recognition, natural language processing, and predictive algorithms,

Module 4 – Bias Mitigation and Future Opportunities
Quantify of bias, Various methods of algorithmic fairness to mitigate this bias, uses of analytics and AI/ML to transform a current biased data-set into a more objective solution.

Text Books:

1. Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy by Cathy O'Neil (2016)

Reference Books:

1. AI ethics by mark Coeckelbergh, MIT Press, 2020.
2. S.Matthew Liao, Ethics of Artificial Intelligence, Oxford University Press, 2020

Course Code	**ECL103**	**Course Title**	**Applied Electronics**			
Category	**Core**	**Credit Assigned**	**L**	**T**	**P**	**C**
			3	**0**	**2**	**3**
Pre-requisite (If any)	**-**	**Type of Course**	**Electronics Engineering**			

Course Contents:

Module 1: ELECTRONIC DEVICES
Theory of P-N Junction Diode, Junction Transistors Theory of Operation, Static Characteristics, Break Down Voltages, Current Voltage Power Limitations, Field Effect Transistor & MOSFET, Principle of Operation & Characteristics.

Module 2: APPLICATIONS of ELECTRONIC DEVICES
Rectifiers, Zener Diode as Regulators, Biasing of BJT Different Biasing Arrangements, Stability Factor, Small Signal Analysis & High Frequency Analysis of BJT, Power Amplifiers, Push Pull Configuration, Complimentary Symmetry, Feedback Amplifiers, RC, LC & Crystal Oscillators.

Module 3: COMBINATIONAL and SEQUENTIAL LOGIC
Logic minimization using K-map method, multiplexers, demultiplexers, decoders, encoders, Arithmetic circuits, Adders, Combinational multiplier and code converters. Basic latches, master-slave latch, Flip flops, Registers, Counters.

Module 4: MEMORIES
Introduction to PLA, PAL and ROM, Programmable Logic Devices and FPGAs.

Module 5: INTRODUCTION TO MICROPROCESSORS
Architecture, bus structure, timing diagrams, T-states, machine cycle, instruction cycle. Memory and IO devices interfacing.

Reference Books:

1) Electronic devices and circuit theory / Robert L. Boylestad, Louis Nashelsky
2) Milman and Halkias, "Integrated Electronics", Second Edition, 2011, McGraw Hill.
3) Digital Design by M. Morris Mano and Michael D. Ciletti
4) Microprocessor Architecture, Programming, and Applications with the 8085 by Ramesh Gaonkar

Course Code:	HUL 102	Course Title:	Environmental Studies
Category:	Core	Credit Assigned	L: 2, T: 0, P: 0, C: 0
Pre-Requisite (if Any)	Nil	Type of Course	Basic Science

Course Outcomes:

1. Introduce to various natural resources, their importance and status.
2. Introduce to the concepts of ecosystem, their structure and functions.
3. Introduce to the concept of biodiversity conservation.
4. Introduce to possible causes of various forms of environmental pollution and their consequences, methods of prevention.
5. Introduce to various social and climatic changes due to pollution.

Course Contents:

Natural resources: Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources.

Ecosystem: Concept of an ecosystem, Structure and functions of an ecosystem, Producers, consumers and decomposers, Ecological succession, Food chain, food webs and pyramids.

Biodiversity and its conservation: Introduction, definitions: genetics, species and diversity, Value of biodiversity, Biodiversity at global, national and local level, India as a mega-diversity nation, Hot-spot of biodiversity, Threat to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, Conservation of biodiversity: in-situ and ex-situ conservation.

Environmental pollution: Definition, Causes, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste management: Causes, effects and control measures of urban and industrial wastes. Social issues and environment: Sustainable development, Water conservation, Rain water harvesting, Watershed management Climate change, Global warming, Acid rain, Ozone layer depletion, Nuclear accident, Holocaust, Environmental rules and regulations.

Human population and environment: Population growth, Environment and human health, Human rights, Value education, Role of information technology in environment and human health.

Text:

1. Raj gopalan R., Environmental Studies

Reference:

1. Benny Joseph, Environmental Studies, McGraw Hill.
2. Erach Barucha Environmental Studies University press (UGC).

Course Code	MAL106	Course Title	Probability and Statistics			
Category	Core	Credit Assigned	L	T	P	C
			3	1	0	4
Pre-requisite (If any)	-	Type of Course	Basic Science			

Course Outcomes:

1. Solve problems of basic probability, two types of random variables and their probability functions.

2. Observe and analyze the behaviour of various discrete and continuous probability distributions.
3. Formulate an appropriate null and alternative hypothesis. Perform test of Hypothesis for decision making and validation.
4. Apply the statistics for testing the significance of the given large and small sample data by using t- test, F- test and Chi-square test.
5. Compute and interpret the results of Bivariate and Multivariate Regression and Correlation Analysis, for prediction and forecasting.

Course Contents:

Probability

Sample space and events – Probability – The axioms of probability – Some Elementary theorems - Conditional probability – Baye's theorem, Random variables – Discrete and continuous, probability density function; probability distribution function for discrete and continuous random variable joint distributions. Definition of mathematical expectation, functions of random variables, The variance and standard deviations, moment generating function other measures of central tendency and dispersion, Skewness and Kurtosis.

Distributions

Binomial , Poisson & normal distributions related properties . Sampling distributions –Sampling distribution of means (known and Unknown).

Testing of Hypothesis I

Tests of hypothesis point estimations – interval estimations Bayesian estimation. Large samples, Null hypothesis – Alternate hypothesis type I, & type II errors – critical region confidential interval for mean testing of single variance. Difference between the mean.

Testing of Hypothesis II

Confidential interval for the proportions. Tests of hypothesis for the proportions single and difference between the proportions. Small samples, Confidence interval for the t- distribution – Tests of hypothesis – t- distributions, F- distributions distribution. Test of Hypothesis.

Regression and Correlation Analysis

Regression and Correlation Analysis: Introduction, Bi-Variate Normal distribution and the associated marginal and conditional distributions, estimation and analysis of simple regression models, correlation coefficients, analysis of correlation coefficients, Hypothesis tests associated with regression and correlation coefficients, curvilinear regression models, Multiple regression models, multiple and partial correlation coefficients.

Text Books:

1. D. K. Murugesan & P. Guru Swamy, "Probability & Statistics", Anuradha Publications.
2. G. S. S. Bhisma Rao, "Probability & Statistics for Engineers", Scitech Publications.
3. Spiegel, Murray, "Probability and Statistics", Schaum's series.

Reference Books:

1. K.V. Iyengar & B. Krishna Gandhi , "Probability & Statistics", S.Chand.
2. William Mendenhall & Others, " Probability & Statistics", Cengage Publications.
3. P. Billingsley, *"*Probability and Measure*"*, John Wiley & Sons (SEA) Pvt. Ltd.
4. W. Feller, *"*An introduction to probability theory and its applications", John Wiley and Sons.

Course Code	**MAL107**	**Course Title**	**Introduction to Linear Algebra**			
Category	**Core**	**Credit Assigned**	**L**	**T**	**P**	**C**
			3	**1**	**0**	4
Pre-requisite (If any)	-	**Type of Course**	**Basic Science**			
Course Outcomes:						

1. Describe properties of linear systems using vectors and Solve systems of linear equations and interpret their results
2. Demonstrate an understanding of linear transformations and Perform and interpret matrix operations
3. Compute and interpret determinants of matrices and Demonstrate an understanding of vector spaces and sub-spaces
4. Demonstrate an understanding of eigenvalues and eigenvectors

Course Contents:

Module-1

Introduction to Vectors, Vectors and Linear Combinations, Lengths and Dot Products, Matrices, Solving Linear Equations,Vectors and Linear Equations,The Idea of Elimination, Elimination Using Matrices, Rules for Matrix, Operations, InverseMatrices, Elimination = Factorization: $A = LU$, Transposes and Permutations Vector Spaces and Subspaces, Spaces of Vectors,The Nullspace of A: Solving $Ax = 0$ and $Rx =$ The Complete Solution to $Ax = b$.

Module-2

Independence, Basis and Dimension, Dimensions of the Four Subspaces, Orthogonality, Orthogonality of the Four Subspaces, Projections, Least Squares Approximations, Orthonormal Bases and Gram-Schmidt Determinants, The Properties of Determinants, Permutations and Cofactors, Cramer's Rule, Inverses, and Volumes, Eigenvalues and Eigenvectors, Introduction to Eigenvalues

Module-3

Diagonalizing a Matrix, Systems of Differential Equations, Symmetric Matrices, Positive Definite Matrices, The Singular Value Decomposition (SVD), Bases and Matrices in the SVD, Principal Component Analysis (PCA by the SVD) The Geometry of the SVD Linear Transformations,The Idea of a Linear Transformation

Module-4

The Matrix of a Linear Transformation, The Search for a Good Basis, Complex Vectors and Matrices, Complex Numbers, Hermitian and Unitary Matrices, The Fast Fourier Transform, Applications, Graphs and Networks, Matrices in Engineering, Markov Matrices, Population, and Economics, Linear Programming, Fourier Series: Linear Algebra for Functions.

Module-5

Numerical Linear Algebra, Gaussian Elimination in Practice, Norms and Condition Numbers, Iterative Methods and Preconditioners, Mean, Variance, and Probability, Covariance Matrices and Joint Probabilities,Multivariate Gaussian and Weighted Least Squares, Matrix Factorization

Text Books:

1. Kenneth Hoffman and Ray Kunze: Linear Algebra, Prentice Hall of India limited, New Delhi, 1971.
2. Gilbert Strang : Linear Algebra And Its Applications (Paperback) , Nelson Engineering (2007).
3. Introduction to Linear Algebra: Gilbert Strang

Reference Books:

1. Gilbert Strang: Introduction to Linear Algebra, Wellesley- Cambridge Press, Fourth Edition, 2011.
2. Jin Ho Kwak and Sungpyo Hong, Linear Algebra, Springer, Second edition, 2004.
3. V. Krishnamoorthy et. al., An introduction to linear algebra, Affiliated East West Press, New Delhi.
4. Elementary of Linear Algebra Howard Anton

Course Code:	CSP 201	Course Title:	IT Workshop-I			
Category:	Core	Credit Assigned	L	T	P	C
			0	0	4	2
Pre-Requisite (If Any)	None	Type of Course	Computer Science and Engineering			

Course Outcomes:

1. Effectively use the Unix programming environment - shell, file system, scripts, filters, program development tools.
2. Develop good programming style using Python with usage of packages: math, Cmath and functions.
3. Be familiar with writing of real time application programs using the concepts like class, object, inheritance, constructor, tkinter.
4. Use of effective procedures and tools for data analytics using graphical outcomes: Pandas, numpy, openpyxl and matplotlib.
5. Learn to automate tasks for making predictions using machine learning: scikit learn, countplot.

Course Contents:

Module 1:
Introduction to different tools for identification and possibility of errors in C program – gdb, concepts of "core dump", backtracing using "bt", using "info" to dump all registers, creating watch-list / watch variables. DDD (Data Display Debugger) – introduction and usage, debugging with ddd (step, step into, step over). Using DevCpp and/or VisualStudio b. Setting compiler options and linker options. Unix tools - Awk, sed, Emacs. Make files and automated builds.

Module 2:
Text editors. Users, files, permissions, and processes on Linux. Introduction to shell: Set and Unset a variable, Displaying – using echo, Using Expr & Test, Getting input – using read, Header files of shell script – using Shabang, Sample Shell script program. Assigning a command to a variable, Storing output to a variable, Assigning global value – using Export. Command Line Arguments, Conditional & Looping Statement, Functions.

Module 3:
Advanced Commands: SED, Replacing values in a file, STTY, TOP, Sending an email using MAIL, HERE. Scheduler: Scheduling a job – using 'Crontab', 'at' and 'nohup. Shell Programming: Essential systems administration with shell scripting and elementary Python, Version control. Advanced Shell Scripting: Monitoring a file, Handling Shell Script Interrupts, Extracting data from HTML/XML file, Trapping Signals Database Connectivity, Connecting MYSQL to Shell, Running SQL queries from Shell Script.

Module 4:
Bash and Bash Scripting: Common shell programs, Advantages of BASH, Executing commands, Building blocks, developing good scripting, variables, conditionals, loops, finding logged in users. Writing and Debugging Scripts.

Module 5:
Bash Environment: Shell Initialization files, Quoting characters, Shell expansion, Aliases and More options in Bash. Regular Expressions: Meta characters, Extended regular expressions Using GREP, Pattern matching. Python Integration, Testing and Debugging with Software Development Practice.

Text Books:

1. Christopher Negus “Linux Bible”, Wiley
2. Steve Parker “Shell Scripting: Expert Recipes for Linux, Bash & more” Wrox
3. Richard Petersen “Linux: The Complete Reference”, TMH
4. Robert Collins “Shell Programming and Bash Scripting: Ultimate Beginners Guide Book”, Create Space.