No. 6-38/2025 (M.Sc. Artificial Intelligence) HPU (Acad.)
Himachal Pradesh University, Summer Hill, Shimla-5
(NAAC Accredited "A" Grade University)
"Academic Branch".

Dated: 10 JU

To

1. The Dean, Faculty of Physical Science, HPU, Shimla-5
2. The Controller of Examinations, HPU, Shimla-5.
3. The D.R. Exam. (PG) HPU, Shimla-5.
4. The D.R. Eval./Re-Eval./Conduct, HPU, Shimla-5.
5. The D. R. Secrecy, HPU, Shimla-5. **(with 2 spare copies.)**
6. The S.O. Exam (M.Sc. Artificial Intelligence) HPU, Shimla-5.
7. The Librarian, HPU Main Library, Shimla-5
8. The Incharge, Computer Centre, Examination Wing (PG), HPU, Shimla-5.

Subject: ***Complimentary copy of*** **Plan, Scheme and syllabi for 2 Years M.Sc. Artificial Intelligence**

Sir/Madam,

I am sending herewith a complimentary copy **Plan, Scheme and syllabi for 2 Years M.Sc. Artificial Intelligence** of duly approved by the Standing Committee of Academic Council in its meeting held on 27.05.2025 **vide item No. 8 (iii),** on the recommendations of the concerned Board of Studies (PG) and Faculty w.e.f. 2025-26 as per annexure.

Yours faithfully,

10.6.
Deputy Registrar (Acad.)
HP University Shimla-5.
Dated: 10 JUN 202

Endst. No. Even
Copy to:

1. The Chairman, Deptt. of Artificial Intelligence, HPU, Shimla-5 for information and **send the soft copy in PDF format to web Admin, HPU, Shimla-5 immediately.**
2. The Web Admin, HPU, Shimla-5, with the request to upload this letter with syllabus on the website.
3. The Dealing Assistant Meeting (Acad.), HPU, Shimla-5, for information.
4. Guard file.

10.6.
Deputy Registrar (Acad.)

Annexure-2

Himachal Pradesh University

NAAC Accredited "A" Grade University

Gyan Path, Summer Hill, Shimla 171005

Plan, Scheme, and Syllabus

For the programme

Master of Science (M.Sc.)

in

Artificial Intelligence

(Effective from the session 2025-26)

Department of Data Science & Artificial Intelligence

Faculty of Physical Sciences

Himachal Pradesh University, Shimla - 5

List of Contents

1. Introduction

Artificial Intelligence is amongst the hottest fields of the 21st century that will impact all segments of daily life by 2025. The recent development in Artificial Intelligence is bringing significant social and economic benefits to the world. As our daily lives are seamlessly integrating more and more data-driven applications, the roleof data analytics and artificial intelligence becomes increasingly important in transforming organizations, industries and society in general. Using Artificial Intelligence techniques,digital machines can analyse and learn from big datasets and discover more efficient ways to do complex tasks; thereby, making intelligent decisions with much higher accuracy and speedthan human beings. Thus, the need of the hour is to integrate the power of Artificial Intelligence to every business to boost the global economy by transforming business models across all sectors like science, engineering, banking, sales, finance, marketing, construction, manufacturing, healthcare, travel, hospitality, leisure, environmental monitoring, logistics etc. Hence, the field of Artificial Intelligence has a potential to employ a large quantum of human resources and serve countries all over the globe.

As per World Economic Forum, Data Scientists and Analysts will become the number one emerging role in the world and thus will find job opportunities which are expected to rise appreciably in the years to come. So, academic institutions must take timely initiatives to offer academic programmes to equip aspirants with requisite job oriented skills and training and thereby contribute to meet the global industrial demand of workforce and diversity in AI and Data Science. Further, in higher education institutions, there is an urgent need forincreased collaboration between industry and academia, through creation of channels ofcommunication between faculty and industry, to promote exchange of ideas and expertise. Various avenues of collaboration need to be explored, including workshops, incentives for guest lectures by professionals and institutional arrangements for regular design of courses/curricula in collaboration with the Private Sector Units (PSU).

Master's programme in Artificial Intelligence proposed in this report, andto be started by Himachal Pradesh University under the Faculty of Physical Sciences,

shall beone of such academic platforms, which caters to impart most advanced knowledge, methods and processes to exploit data science-based solutions to real-world problems. After the completion of this course, the students may have career opportunities with exceptional prospective fields of healthcare, business, e-Commerce, social networking companies, climatology, biotechnology, genetics and other important areas.

2. Programme Details:

a. Programme : M.Sc. in Artificial Intelligence

b. Duration : Two (02) Years Programme divided into four (04) Semesters

c. Eligibility : Any Engineering Graduate

Or

Any other graduate with Mathematics/ Computer/IT/Applications/Statistics as Major Subjects in all three years.

With 50% aggregate marks in qualifying exam (45% for SC/ST/PWD)

d. Fee Structure :

Subsidized Seats: ₹40,000/- (Rupees Forty Thousand Only inclusive of ₹5,000/- of equipment fee) annually.

Non-Subsidized Seats: ₹60,000/- (Rupees Sixty Thousand Only inclusive of ₹5,000/- of equipment fee) annually.

e. Student Intake :

Total Seats:

Subsidized Seats: **15+02+02+03*** (Supernumerary 02 seats Reserved for Single Child who is a Girl + Supernumerary 02 seats Reserved for J&K migrants + 03* seats for EWS of H.P.)

Non-Subsidized Seats: **15+03** (Supernumerary 03 seats for Wards of H.P. University Employees)

Total Seats in M.Sc. Artificial Intelligence Course:

15+02+02+03*+15+03=40

There are 10% additional seats reserved for the Economically Weaker Section (EWS) category for admission and all are the subsidized seats.
If these seats remain vacant then these seats neither be filled with other category nor will carry forward.
Supernumerary seats as per university norms for foreign National who apply through ICCR are also available as per H.P. University Rules.

f. Mode of Admission: On the basis of Merit of Entrance Test

The admission to this course will be made on the basis of merit of the Entrance Examination(written test) conducted by H.P. University.

Written test	**100 Marks**
Duration of test	**1:30 Hours**

The written test shall include the following three sections:

Sr. No	Contents	Marks
1.	ICT Awareness	**60**
2.	Mathematics	**20**
3.	General Logic Ability & Aptitude	**20**
Total		**100**

The minimum qualifying marks in the Entrance Examination (written test) for subsidized as well as non-subsidized seats will be 35%.

Age Limit:

There is no age bar as such.

RESERVATION:

I. Subsidized Seats

a. 15% and 7.5% of the seats shall be reserved for bonafide Himachali Scheduled Castes and Scheduled Tribes candidates respectively who have passed their qualifying examination from Himachal Pradesh University or from any other University established by law in India which is equivalent to the qualifying examination of H.P. University.

b. The remaining seats shall be filled as under

i. 25% seats shall be open for all the candidates irrespective of the institution from where they have passed their qualifying examination.

ii. 75% of the seats shall be filled out of the candidates who have passed their qualifying examination from Himachal Pradesh University or H. P. Krishi Vishva Vidyalaya or Dr. Y. S. Parmar University of Horticulture and Forestry or Himachal Pradesh Technical University or Central University of Himachal Pradesh or the candidates who are

Himachal Pradesh domicile irrespective of passing qualifying examination from any other university established by law in India which is equivalent to the qualifying examination of Himachal Pradesh University, subject to the following reservation: 5% of the seats shall be reserved for Physically Handicapped candidates with a minimum of 40% disability and who are Himachal Pradesh Domicile.

iii. Two supernumerary seats shall be reserved for Himachali Bonafide only single child who is a girl. In this respect, an affidavit issued by a competent authority in original shall have to be submitted by the candidate at the time of counselling.

iv. There are 10% additional seats reserved for the Economically Weaker Section (EWS) category for admission. If these seats remain vacant then these seats neither be filled with other category nor will carry forward.

v. Two supernumerary seats shall be reserved for the students of the state of Jammu and Kashmir Migrants.

vi. Supernumerary seats as per university norms for foreign National who apply through ICCR are also available as per H.P. University Rules.

II. Non-Subsidized Seats

a. 15% and 7.5% of the seats shall be reserved for bonafide Himachali Scheduled Caste and Scheduled Tribe candidates respectively who have passed their qualifying examination from Himachal Pradesh University or from any other University established by law in India which is equivalent to the qualifying examination of H.P. University.

b. The remaining seats shall be filled as under

i. 25% seats shall be open to all the candidates irrespective of the institution from where they have passed their qualifying examination.

ii. 75% of the seats shall be filled out of the candidates who have passed their qualifying examination from Himachal Pradesh University or H. P. Krishi Vishva Vidyalaya or Dr. Y. S. Parmar University of Horticulture and Forestry or Himachal Pradesh Technical University or Central University of Himachal Pradesh or the candidates who are Himachal Pradesh domicile irrespective of passing qualifying examination from any other university established by law in India which is equivalent to the qualifying examination of Himachal Pradesh University.

iii. Three supernumerary seats shall be reserved for wards of H.P. University Employee.

III. Reservation Roster

The reserved seats shall be worked out on the basis of the existing 120-point roster.

1PwD	26SC	51	76	101PwD
2	27ST	52SC	77	102
3	28	53ST	78SC	103
4	29	54	79SP	104
5	30	55	80ST	105
6	31	56	81CUL	106SC
7SC	32	57	82 (PwD)	107ST
8	33SC	58	83	108
9	34	59SC	84	109
10	35	60SP	85SC	110
11	36	61CUL	86	111
12SC	37	62 (PwD)	87	112
13ST	38CUL	63	88	113SC
14	39SC	64	89	114
15	40SP	65SC	90	115
16	41ST	66	91SC	116
17	42(PwD)	67ST	92	117SP
18SC	43	68	93ST	118CUL
19SP	44	69	94	119SC
20CUL	45	70	95	120ST
21PwD	46SC	71	96	
22	47	72SC	97SC	
23	48	73	98CUL	
24	49	74	99SP	
25	50	75	100	

(PwD-5%) (CUL-5%) (SP-5%) (SC-15%) (ST-7.5%)

PwD : Person with Disability; CUL : Cultural; SP : Sports; SC : Scheduled Caste and ST : Scheduled Tribe.

3. Examinations:

As the degree is spanned over two years and distributed into four semesters, the learning outcomes shall be assessed after every semester. The assessment of the students shall consist of the following components:

Sr. No.	Assessment Component
1	Semester End External Examinations (Theory)
2	Internal Assessment (Theory)
3	Semester End External Examinations (Practical)
4	Internal Assessment (Practical)
5	Project Work Evaluation

Note: The concerned subject teacher shall submit the marks of Internal Assessment (Theory), Internal Assessment (Practical), and Semester End Examinations (Practical) to theChairman/Head of the Department (as per the schedule mentioned in Academic Calendar) in triplicate - first copy

for Examination Branch of HPU, second copy as an Office copy of the Department, and the third copy may be retained by the subject teacher.

Internal assessment will be given on the basis of class tests (best of 2 in a semester), seminars, surprise quizzes, class participation and regularity of the student in the class, be evaluated by the department and the award list shall be sent to the examination branch by the Chairman/HOD.

In the third semester, the Chairman/Head of the Department will assign a guide/supervisor to each candidate for his/her project work. The candidate shall be required to maintain his/her project diary (logbook) of work in the organization/department. Each student will be requiredto give at least two seminars on his/her project work. Each student is required to submit three copies of his/her project reports in the department after completion of the project work which will be evaluated by an external examiner.

Further, the project work (final semester) will be jointly evaluated by an internal guide and external examiner.

Scheme of Examination:

English shall be the medium of instruction and examination. The pass marks in each course shall be 40% in each written paper and in the internal assessment separately, and 40% in viva-voce, project work and semester course and 50% in the aggregate subject to the conditions that aggregate shall be determined at the end of the examination. Other rules shall be as per the rules of the university.

Theory Papers:

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions from each units and will carry 27 marks out of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

Practical Examination

Each paper will be of 75 marks (50 marks for practical exam and 25 marks for internal assessment) and duration of each paper will be 3 hours. The marks awarded by the teacher on account of internal assessment in relation to theory/practical paper as mentioned above shall be submitted to the office of Chairman.

Conduct:

Practical exam will be conducted by the external examiner from the panel submitted by Chairman, Department of Data Science and Artificial Intelligence, Himachal Pradesh University and duly approved by the university authority/evaluation branch, Himachal Pradesh University, Shimla.

Project Work:

In 2nd year (fourth semester) the student has to develop one software project, which will be evaluated by the external examiner from the panel submitted by Chairman, Department of Data Science and Artificial Intelligence, Himachal Pradesh University, and duly approved by the university authority/evaluation branch, Himachal Pradesh University, Shimla on the following basis:

System Development Project:

Seminar (2)	50 marks
Log Book & Interim Report	50 marks
Internship/Project Report	100 marks
Viva-Voce	250 marks
Total	**450 marks**
OR	
Seminar (2)	50 marks
Log Book & Interim Report	50 marks
Elective 4	100 marks
Project Report	100 marks
Viva-Voce	150 marks
Total	**450 Marks**

In fourth semester, the Chairman/Head of the Department will assign a guide/supervisor, to each candidate for his/her project work. The candidate shall be required to maintain his/her project diary (logbook) of work in the organization. Each student will be required to give at least two seminars on his/her project work. Each student is required to submit three copies of his/her project reports in the Department after completion of the project work which will be evaluated by external examiner.

4. Minimum Criteria to Award the Degree

Rules regarding the minimum criteria to award a Degree of Master of Science in Artificial Intelligence shall remain the same as applicable in other Master of Science programmes run by HPU.

5. Honorarium

1. All the teachers shall be paid an honorarium on lecture basis as per university norms for all the lectures taken for engaging theory as well as practical classes in the M.Sc. Artificial Intelligence. course in the department.
2. Remuneration for evaluation of answer-scripts(Theory) exam of M.Sc. Artificial Intelligence @ ₹25/- per answer-script subject to minimum of ₹150/-
3. **Remuneration charges for the conduct of practical/Viva-voce for External Examiners:**
    i. Sitting charges per session per day for the answer sheets of practical examination @ ₹25/- per answer-sheet.
    ii. Sitting charges per session per day for practical- as per university norms
    iii. Project evaluation-₹100 per student
    iv. TA/DA - As per the University norms
4. All the expenditure incurred with respect to the honorarium etc. shall be met out of the funds generated through the running of M.Sc. Artificial Intelligence course.

Master of Science

in

Artificial Intelligence

M. Sc. (Data Science)

Scheme

&

Syllabus

Credit Based System

Effective from

Academic Session 2025-2026

PROGRAMME OUTCOMES (POs)	
PO1	Knowledge: Capable of demonstrating comprehensive disciplinary knowledge gained during course of study.
PO2	Research Aptitude: Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusions from the analysis.
PO3	Problem Investigation & Solving: a) Ability of critical thinking, analytical reasoning, and research-based knowledge including design of experiments, analysis, and interpretation of data to provide conclusions, and b) Capability of applying knowledge to solve scientific and other problems.
PO4	Individual/Team Work and Modern Tool Usage: Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings with or without the developed capabilities of modern tools.
PO5	Science and Society: Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices.
PO6	Life-Long Learning: Motivation to take higher studies and aptitude to apply knowledge and skills that are necessary forparticipating in learning activities throughout life.
PO7	Ethics: Capability to identify and apply ethical issues related to one's work, avoid unethical behaviour such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work.
PO8	Project Management: Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects.

PROGRAMME SPECIFIC OUTCOMES (PSOs)	
PSO1	Demonstrate expertise in foundational AI concepts, including probability, statistics, data structures, and Python programming.
PSO2	Apply machine learning, deep learning, and NLP techniques to solve real-world problems, demonstrating proficiency in experimentation and analysis.
PSO3	Design and implement robust AI systems for tasks within computer vision, image processing, and optimization.
PSO4	Analyze large datasets using big data tools, create compelling data visualizations, and extract actionable insights.
PSO5	Utilize computational intelligence techniques like genetic algorithms and explore applications of AI in robotics.

Abbreviations Used:

L	LECTURES
T	TUTORIALS
P	PRACTICALS
C	CREDITS
H	HOURS
EE	EXTERNAL EXAMINATIONS
IA	INTERNAL ASSESSMENT
WAP	WRITE A PROGRAM
PO	PROGRAM OUTCOME
CO	COURSE OUTCOMES
PSO	PROGRAM SPECIFIC OUTCOMES

Semester-I

Sr. No	Course Code	Course Title	Contact Hrs/week				C	Semester End Marks	
			L	T	P	H		EE	IA
1.	MSAI-101	Probability and Statistics	4	0	0	60	4	75	25
2.	MSAI -102	Data Structures and Algorithms	4	0	0	60	4	75	25
3.	MSAI 103	Python Programming	4	0	0	60	4	75	25
4.	MSAI -104	Introduction to Data Science & Artificial Intelligence	4	0	0	60	4	75	25
5.	MSAI -105	Data Mining	4	0	0	60	4	75	25
6.	MSAI -151	Data Structures with Algorithms using C – Lab	0	0	4	60	2	50	25
7.	MSAI -152	Python Programming - Lab	0	0	4	60	2	50	25
TOTAL							24	475	175
								Total = 650	

Semester-II

Sr. No	Course Code	Course Title	Contact Hrs/week				C	Semester End Marks	
			L	T	P	H		EE	IA
1.	MSAI -201	Machine Learning	4	0	0	60	4	75	25
2.	MSAI -202	Big Data Analytics and Data Visualisation	4	0	0	60	4	75	25
3.	MSAI -203	Introduction to Computer Vision and Image Processing	4	0	0	60	4	75	25
4.	MSAI-204	Optimization Techniques	3	0	0	45	3	75	25
5.	MSAI-EL	Elective 1	3	0	0	45	3	75	25
6.	MSAI-251	Big Data Analytics and Data Visualization - Lab	0	0	4	60	2	50	25
7.	MSAI-252	Machine Learning - Lab	0	0	4	60	2	50	25
TOTAL							22	475	175
								Total = 650	

Semester-III

Sr. No	Course Code	Course Title	Contact Hrs/week				C	Semester End Marks	
			L	T	P	H		EE	IA
1.	MSAI-301	Deep Learning	4	0	0	60	4	75	25
2.	MSAI-302	Natural Language Processing	4	0	0	60	4	75	25

3.	MSAI-303	Advances in AI	**4**	**0**	**0**	**60**	**4**	75	25
4.	MSAI-EL	Elective 2	**3**	**0**	**0**	**45**	**3**	75	25
5.	MSAI-EL	Elective 3	**3**	**0**	**0**	**45**	**3**	75	25
6.	MSAI-351	Deep Learning- Lab	**0**	**0**	**4**	**60**	**2**	50	25
7.	MSAI-352	Natural Language Processing-Lab	**0**	**0**	**4**	**60**	**2**	50	25
TOTAL							**22**	**475**	**175**
								Total = 650	

Semester-IV

Sr. N.	Course Code	Course Title	Evaluation Components	C	Semester End Marks	
					EE	IA
1.	MSAI-401	**Project Work**	Seminar (2)	**2**		50
			Log Book & Interim Report	**2**		50
			Internship/Project Report	**4**		100
			Viva-Voce	**10**	250	
			Total	**18**	**250**	**200**
					Total =450	
			OR			
			Seminar (2)	**2**		50
			Log Book & Interim Report	**2**		50
			Elective 4	**4**	75	25
			Internship/Project Report	**4**		100
			Viva-Voce	**6**	150	
TOTAL				**18**	**225**	**225**
					Total =450	

Total Credits : 24+22+22+18 = **86**
Total Maximum Marks : 650+650+650+450 = **2400**

LIST OF ELECTIVE COURSES

NAME OF COURSE	COURSE CODE
1. ELECTIVE 1	
a) Database Management System	MSAI-EL-211
b) Information Retrieval	MSAI-EL-212
c) Software Engineering	MSAI-EL-213
2. ELECTIVE 2	
a) Data Engineering	MSAI-EL-311
b) Soft Computing	MSAI-EL-312
c) Introduction to Robotics, Sensing & Visualization	MSAI-EL-313
3. ELECTIVE 3	
a) Text Processing and Pattern Recognition	MSAI-EL-321
b) Evolutionary Computing	MSAI-EL-322
c) Cognitive System	MSAI-EL-323
4. ELECTIVE 4	
a) Virtual Reality and Augmented Reality	MSAI-EL-411
b) Introduction to Block Chain	MSAI-EL-412
c) Multi Agent System	MSAI-EL-413

DETAILED SYLLABUS

SEMESTER-I

Name of the Course	Probability And Statistics		
Course Code	**MSAI-101**	Credits-4	L-4, T-0, P-0
Lectures to be Delivered	60 (1 Hr Each) (L=60, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Calculate and interpret probabilities using various distributions.
CO2	Analyze data sets using descriptive statistics.
CO3	Conduct hypothesis tests to evaluate statistical claims about populations.
CO4	Apply correlation and regression techniques to model relationships between variables.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-101 Probability and Statistics

UNIT-I

Introduction: Probability, Bayes Theorem, Conditional expectation and variance, mean, median, mode and standard deviation, Random Variables & Probability Distributions: Discrete and continuous random variables - distribution function and its properties ,Joint Probability Law, probability mass function and probability density function - discrete and continuous probability distributions – Bernoulli Distribution, Binomial, Geometric, Poisson,Uniform, Exponential and Normal distributions, Cumulative distribution function.

UNIT-II

Types of Data: primary and secondary data - classification and representation of data - formation of frequency distribution - various measures of central tendency, dispersion - and their merits and demerits - concept of skewness and kurtosis. Sampling, analysis of sample data - Empirical Distributions, Sampling from a Population Estimation, confidence intervals, point estimation-Maximum Likelihood.

UNIT-III

Testing of Hypothesis I : Concept of large and small samples – Tests concerning a single population mean for known σ – equality of two means for known σ- Test for single variance – Test for equality of two variance for normal population – Tests for single proportion – Tests of equality of two proportions for the normal population.

Test of Hypothesis: Z, t, Chi-Square & F-test. ANOVA & Designs of Experiments--Single, Two factor ANOVA, Factorials ANOVA models.

UNIT-IV

Correlation and Curve Fitting: Correlation coefficient and regression - rank correlation - curve fitting by least square methods, fitting a straight line, parabola, power curve and exponential curves. (no derivation, numerical problems only) Correlation & Regression Models-- linear regression methods, Ridge regression, LASSO, univariate and Multivariate Linear Regression, probabilistic interpretation, Regularization, Logistic regression, locally weighted regression.

Text Books:

1. Gupta, S.C. and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons,New Delhi, 10th edition, 2002.
2. T. Veerarajan, Probability, Statistics and Random Processes, Tata McGraw Hill, 3rd edition, 2017.
3. Robert V Hogg, Elliot A Tannis and Dale L.Zimmerman, Probability and Statistical Inference,10th edition, Pearson publishers,2021

Reference Books:

1. Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers,Third Edition, John Wiley & Sons Inc., 6th edition, 2016.
2. Ronald E. Walpole, Raymond H Myres, Sharon. L. Myres and Kying Ye, Probability and Statisticsfor Engineers and Scientists, 9th edition, Pearson Education, 2010.
3. Richard Arnold Johnson, Irwin Miller, John E. Freund , Miller & Freund's Probability andStatistics for Engineers, 8th edition, Prentice Hall, 2011.
4. Goon, A.M., M. K. Gupta and B. Das Gupta Fundamentals of Statistics- Vol. I, World Press Ltd,Kolkata, 2013.
5. Brian Caffo, Statistical Inference for Data Science, Learnpub, 2016.

6. Hogg, R.V. and A. Craig, Introduction to Mathematical Statistics,7th edition, Pearson Education, 2012..
7. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, An Introduction to StatisticalLearning with Applications in R, Springer 2017.
8. Dr. P. Kandaswamy, Dr. K. Thilagavathy and Dr. K. Gunavathy, Probability and Queuing Theory,Revised edition, S. Chand Publishing, 2013.

Name of the Course	Data Structures and Algorithms		
Course Code	**MSAI-102**	Credits-4	L-4, T-0, P-0
Lectures to be Delivered	60 (1 Hr Each) (L=60, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Analyze the efficiency of algorithms using asymptotic notations and apply this knowledge to design solutions.
CO2	Implement fundamental data structures and demonstrate their operations.
CO3	Design and implement sorting algorithms and search algorithms.
CO4	Construct and apply tree and graph data structures and their associated algorithms

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-102 Data Structures and Algorithms

UNIT- I

Introduction to Data Structures and Algorithms: Primitive and Composite data types, Classification of Data Structures, algorithm, complexity of algorithms, analyzing algorithms, designing algorithms, asymptotic notations.

Arrays, and their operations (insertion, deletion, traversing), Linked Lists (traversal, insertion, deletion), and type (linear, circular, doubly linked, inverted).

UNIT-II

Stacks & Queues: Representation of Stacks, Stack Operations, Application of stacks (converting arithmetic expression from infix notation to polish and their subsequent evaluation, recursion), Queues, Operations on Queues, Circular Queues, Dequeue, Priority Queues.

Searching & Sorting: Linear Search, Binary Search, Selection Sort, Insertion Sort, Bubble Sort. Implementation of these searching and sorting through algorithms.

UNIT-III

Trees and graphs: binary trees and their types, representation in memory, Threaded Binary Trees, Binary Search Trees and Operations, AVL Trees, heap, M-way Search Trees, B-Trees, B+ Trees, hashing, Graph representation and traversal (BFS and DFS), Divide and Conquer: The General Method, Merge Sort, Quick Sort.

UNIT-IV

Greedy Algorithms: General Method, Knapsack problem, Job sequencing with deadlines, Minimum Spanning Trees, Kruskal's Algorithm, Prim's Algorithm, and Dijkstra's Single Source Shortest Path Algorithm.

Dynamic Programming: The General Method, All Pairs Shortest Paths, 0/1 Knapsack, Traveling Salesperson Problem.

Text Books:

1. Seymour Lipschutz, "Data Structures", McGraw Hill Education, Revised edition, 2014.
2. T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein, Introduction to Algorithms, Prentice-Hall of India, 4th edition, 2022.

Reference Books:

1. Parag H. Dave, Himanshu B. Dave, Design and Analysis of Algorithms, Pearson Education, 3rd edition, 2021.
2. Jean Paul Tremblay & Paul G. Sorenson, "An Introduction to Data Structures with Applications", Tata McGraw Hill Publications,1984.

Name of the Course	**Python Programming**		
Course Code	**MSAI-103**	Credits-4	L-4, T-0, P-0
Lectures to be Delivered	60 (1 Hr Each) (L=60, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Demonstrate proficiency in core Python programming concepts.
CO2	Apply numpy for numerical data manipulation, including array creation, indexing, and mathematical operations.
CO3	Utilize pandas to perform data cleaning, preparation, analysis, and visualization.
CO4	Implement exception handling techniques to create robust and error-free Python code.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-103 Python Programming

UNIT-I

Basics of Python Programming: Features of Python, History and Future of Python, Writing and executing Python program, Literal constants, variables and identifiers, Built-in Data types and their Methods: Strings, List, Tuples, Dictionary, Set, Input operation, Comments, Reserved words, Indentation, Operators and expressions, Expressions in Python, Math and Random number functions. User defined functions - function arguments & its types.

UNIT-II

Decision Control Statements: Decision control statements, Selection/conditional branching Statements: if, if-else, nested if, if-elif-else statements. Basic loop Structures/Iterative statements: while loop, for loop, selecting appropriate loop. Nested loops, the break, continue, pass, else statement used with loops.

Need for functions, Function: definition, call, variable scope and lifetime, the return statement. Defining functions, Lambda or anonymous function, documentation string, good programming practices. Introduction to modules, Introduction to packages in Python, Introduction to standard library modules. Exception Handling: Built-in Exceptions, Handling Exceptions, Exception with Arguments, User-defined Exceptions

UNIT-III

Arrays and Vectorized Computation: The NumPy ndarray - Creating ndarrays - Data Types for ndarrays - Arithmetic with NumPy Arrays- Basic Indexing and Slicing - Boolean Indexing- Transposing Arrays and Swapping Axes. Universal Functions: Fast Element-Wise Array Functions- Mathematical and Statistical Methods-Sorting Unique and Other Set Logic.

Data Cleaning and Preparation: Handling Missing Data, Data Transformation: Removing Duplicates, Transforming Data Using a Function or Mapping, Replacing Values, Detecting and Filtering Outliers String Manipulation: Vectorized String Functions in pandas, Plotting with pandas: Line Plots, Bar Plots, Histograms and Density Plots, Scatter or Point Plots.

UNIT-IV

Series, Data Frame, Essential Functionality: Dropping Entries Indexing, Selection, and Filtering- Function Application and Mapping, Sorting and Ranking. Summarizing and Computing Descriptive Statistics- Unique Values, Value Counts, and Membership. Reading and Writing Data in Text Format. Frequency tables. Simple Aggregation in Pandas GroupBy: Split, Apply, Combine.

Text Books:

1. Mark Lutz, Learning Python, O'Reilly, 5th Edition, June 2013**.**
2. Wes McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and I Python, O'Reilly, 3rd Edition, August 2022.

Reference Books:

1. Y. Daniel Liang, Introduction to Programming using Python, Pearson, 2012.
2. Wesley J. Chun, Core Python Applications Programming,3rd Edition, Pearson,2012.
3. R. Nageswara Rao, "Core Python Programming", Dreamtech Press; Third edition,2021

4. Reema Thareja, "Python Programming Using Problem Solving Approach", 2nd Edition,Oxford University Press,2019.
5. Jake Vander Plas ,Python Data Science Handbook O'Reilly, 2nd Edition ,2022.

Name of the Course	**Introduction to Data Science and Artificial Intelligence**		
Course Code	**MSAI-104**	Credits-4	L-4, T-0, P-0
Lectures to be Delivered	60(1 Hr Each) (L=60, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Explain the fundamental concepts, processes, and components of data science, including its applications in business problem-solving.
CO2	Apply data preprocessing techniques to prepare datasets for analysis.
CO3	Utilize SQL and nosql databases to store, retrieve, and manipulate data for data science tasks.
CO4	Implement basic data analysis and visualization techniques using Python (or R) and relevant libraries.
CO5	Describe the foundations of artificial intelligence, including problem-solving techniques, knowledge representation, and intelligent agents.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-104 Introduction to Data Science and Artificial Intelligence

UNIT-I

Introduction to Data Science: Importance of Data Science, Need for Data Science**,** Data Science Process**,** business intelligence and data science, components of data science, tools and skills needed.

Data: structured data, unstructured data, challenges with unstructured data, Data pre-processing: data cleaning, data integration, data transformation, data reduction, data discretization.
D**ata Modeling and Analytics**: data science methodology, analytics for data science, data analytics life cycle, data discovery, data preparation, model planning, model building, communicate results, operationalization.

UNIT-II

Databases for Data Science /Platforms for Data Science: SQL tools for data science, basics statistics with SQL, data munging with SQL, preparing data for analytics tool, advanced NOSQL for data science, document databases for data science, wide-column databases for data science.
Platforms for Data Science: basics of python for data science, python libraries: data frames manipulation with pandas and numpy, exploration data analysis with python, python IDEs for data science.
data science tool R: reading and getting data into R, writing data into files, scan() function, built in data sets, ordered and unordered factors, array and matrices, creating an array, accessing elements in an array, array manipulation, matrices, creating a matrix, matrix transpose, Data visualization.

UNIT-III

Introduction to AI: Introduction to Artificial Intelligence, various definitions of AI, AI Applications and Techniques, Turing Test and Reasoning - forward & backward chaining.
Intelligent Agents: Introduction to Intelligent Agents, Rational Agent, their structure, reflex, model-based, goal-based, and utility-based agents, behavior and environment in which a particular agent operates, Expert System Architectures and Development, Applications of Expert System, Representing and using domain knowledge, Expert System Shells, Knowledge Acquisition, Different types of uncertainty - degree of belief and degree of truth.

UNIT-IV

Problem-Solving and Search Techniques: Problem Characteristics, Production Systems, Control Strategies, Breadth First Search, Depth First Search, iterative deepening, uniform cost search, Hill climbing and its Variations, simulated annealing, genetic algorithm search; Heuristics Search Techniques: Best First Search, A* algorithm, AO* algorithm, Minmax & game trees, refining minmax, Alpha – Beta pruning, Constraint Satisfaction Problem, Means-End Analysis.
Knowledge Representation: Introduction to First Order Predicate Calculus, Resolution Principle, Unification, Semantic Nets, Conceptual Dependencies, semantic networks, Frames system, Production Rules, Conceptual Graphs, Ontologies.

Text Books:

1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 4th edition, Pearson Education, 2022
2. Elaine Rich and Kelvin Knight, Artificial Intelligence, 3rd edition, Tata McGraw Hill , 2017
3. Sanjeev J. Wagh, Manisha S. Bhende, Anuradha D. Thakare, Fundamentals of Data Science, CRC 2021

Reference Books:

1. Michael Wooldridge, An Introduction to MultiAgent Systems, 2nd edition, John Wiley & Sons, 2009.
2. Tom Markiewicz, Josh Zheng, Getting Started with Artificial Intelligence,2nd edition, O'Reilly, 2020.
3. Ivan Bratko, Prolog Programming for Artificial Intelligence, Addison-Wesley, Pearson Education, 4th edition, 2011.
4. Fabio Luigi Bellifemine, Giovanni Caire, Dominic Greenwood, Developing Multi-Agent Systems with JADE, Wiley Series in Agent Technology, John Wiley & Sons, 2007.
5. Charu C. Aggarwal, Artificial Intelligence, Springer, 2021.

Name of the Course	**Data Mining**		
Course Code	**MSAI-105**	Credits-4	L-4, T-0, P-0
Lectures to be Delivered	60 (1 Hr. Each) (L=60, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 Hrs.**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Understand the fundamentals of data mining and knowledge discovery processes.
CO2	Implement clustering algorithms like k-means, hierarchical, and DBSCAN methods.
CO3	Apply sequential pattern mining algorithms to discover patterns in time-series data.
CO4	Utilize big data tools such as Hadoop for mining large-scale datasets.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions from each unit and will carry 27 marks out of the total marks of the semester end examination for the course. Sections A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester-end examination for the course.

For candidates: Candidates must attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-105 Data Mining

UNIT-I

Foundations of Data Mining: Definition of data mining, the knowledge discovery process, applications in real-world domains, challenges in mining various types of data (structured, semi-structured, unstructured), data pre-processing techniques, data cleaning, data integration, transformation, reduction, feature selection, dimensionality reduction methods (PCA, SVD), outlier detection methods, introduction to data warehousing, OLAP systems.

UNIT-II

Clustering and Association Rule Mining: Clustering techniques from **"Data Mining: Concepts and Techniques"**, partitioning (k-means, k-medoids), hierarchical clustering, density-based clustering (DBSCAN), grid-based methods, evaluation of clustering results, association rule mining, Apriori algorithm, FP-Growth algorithm, correlation analysis in association rule mining, multi-level and multi-dimensional association rule mining.

UNIT-III

Web, Text, and Sequential Pattern Mining: Web mining techniques, including content, structure, and usage mining from "Mining the Web", introduction to text mining from "Introduction to Data Mining"**,** pre-processing (tokenization, stemming, stop word removal), mining sequential patterns (GSP, Prefix Span), mining time-series data, applications in real-world domains (e.g., e-commerce, social media).

UNIT-VI

Advanced-Data Mining and Big Data Analytics: Spatial data mining from **"**Data Mining: Concepts and Techniques", mining multimedia data, time-series data mining, anomaly detection techniques, big data mining with Hadoop and Map Reduce, ethical considerations in data mining (privacy, bias, security), case studies from healthcare, finance, and marketing, hands-on experience with data mining tools (Weka, R, Python libraries).

Text Books:

1. Jiawei Han, Micheline Kamber, Jian Pei, *Data Mining: Concepts and Techniques*, 4th Edition, 2022, Morgan Kaufmann.ss
2. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining, 2nd Edition, 2018, Pearson.
3. Soumen Chakrabarti, Mining the Web: Discovering Knowledge from Hypertext Data, 1st Edition, 2003, Morgan Kaufmann.

Reference Books:

1. Han, J., Kamber, M., & Pei, J. (2011). *Data Mining: Concepts and Techniques* (3rd ed.). Morgan Kaufmann.
2. Tan, P.-N., Steinbach, M., & Kumar, V. (2005). *Introduction to Data Mining*. Pearson Addison-Wesley.
3. David J. Hand, Heikki Mannila, Padhraic Smyth, *Principles of Data Mining*, 1st Edition, 2001, MIT Press
4. Hand, D. J., Mannila, H., & Smyth, P. (2001). *Principles of Data Mining*. MIT Press.
5. Chakrabarti, S. (2003). *Mining the Web: Discovering Knowledge from Hypertext Data*. Morgan Kaufmann.

Name of the Course	Data Structures and Algorithms Using C Lab		
Course Code	**MSAI-151**	Credits-2	L-0, T-0, P-4
Lectures to be Delivered	**60 hours of Lab Sessions**		
Semester End Examination	**Max Marks: 50**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Implement fundamental algorithms for numerical problems, sorting, and searching.
CO2	Demonstrate proficiency with arrays and pointers for data manipulation.
CO3	Design and utilize core data structures (linked lists, stacks, queues) and their associated operations.
CO4	Apply tree data structures and demonstrate traversal techniques.

MSAI-151 Data Structures and Algorithms Using C Lab

List of Practicals:

1. Write a program to find whether the entered number is Armstrong or not.

2. Write a program to find whether the entered number is prime or not.

3. Write a program to find the factorial of any number.

4. Swap the value of two variables using call by value & by reference.

5. Write a program to: a) add a number to the given array and b) Delete a number from the given array.

6. Write a program using pointers to find the smallest number in an array.

7. Write a program to calculate the sum of all digits on a number.

8. Write a program to multiply two matrices.

9. Write a program to Count the total number of vowels and consonants in a string.

10. Implement the Selection Sort

11. Implement Bubble Sort

12. Implement Insertion Sort

13. Implement the Linear Search

14. Implement Binary Search.

15**. Implement the following:**

a). Inserting a node into the Linked List (First Node, Last Node, and nth Node)

b). Deleting a node from the Linked List (First Node, Last Node, and nth Node)

16. Implement Stack and its operations using arrays and Linked List.

17. Implement Queue and its operations arrays and Linked List.

18. Implement circular queue.

19. Implement binary tree and traverse it using in-order, pre-order, and post-order.

20. Implement queue by using stacks.

Name of the Course	**Python Programming-Lab**		
Course Code	**MSAI-152**	Credits-2	L-0, T-0, P-4
Lectures to be Delivered	**60 Hours of Lab Sessions**		
Semester End Examination	**Max Marks: 50**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Demonstrate proficiency in manipulating numerical and string data types in Python.
CO2	Apply fundamental Python programming concepts (data structures, control flow, functions, and recursion) to solve practical problems.
CO3	Utilize Python modules and functions to implement mathematical algorithms
CO4	Explore the use of Python's lambda functions for concise programming solutions.

MSAI-152 Python Programming -Lab

1. Write a program to demonstrate different number data types in Python.
2. Write a program to perform different Arithmetic Operations on numbers in Python.
3. Write a program to create, concatenate and print a string and accessing sub-string from a given string.
4. Write a python script to print the current date in the following format “Sun May 29 02:26:23 IST 2024”.
5. Write a program to create, append, and remove lists in python, demonstrate working with tuples, dictionaries in python.
6. Write a Python program to convert temperatures to and from Celsius, Fahrenheit. [Formula : c/5 = f-32/9]
7. Write a Python script that prints prime numbers less than 20.
8. Write a python program to find factorial of a number using Recursion.
9. Write a program that accepts the lengths of three sides of a triangle as inputs. The program output should indicate whether or not the triangle is a right triangle (Recall from the

Pythagorean Theorem that in a right triangle, the square of one side equals the sum of the squares of the other two sides).

10. Write a python program to define a module to find Fibonacci Numbers and import the module to another program.
11. Write a Python function that prints out the first n rows of Pascal's triangle.
12. Write a Python program to square and cube every number in a given list of integers using Lambda.
13. Write a Python program to create a lambda function that adds 15 to a given number passed in as an argument, also create a lambda function that multiplies argument x with argument y and prints the result.

Sample Output:
25
48

14. Write a program Utilize NumPy functions to create arrays from lists, tuples, or built-in functions.
15. Write a program to Access array attributes like shape, dimensions, and data type, and use methods like reshape, flatten, and transpose.
16. Write a program to Access elements and sub-arrays of NumPy arrays using indexing and slicing techniques.
17. Write a program Concatenate multiple arrays along different axes or split arrays into smaller ones.
18. Write a program Stack arrays horizontally and vertically or perform broadcasting operations
19. Create Pandas DataFrame from dictionaries, lists, or NumPy arrays.
20. Read and write data from various file formats such as CSV, Excel, JSON, SQL, etc., into Pandas DataFrame.
21. Use methods like **head ()**, **tail ()**, **info ()**, **describe ()** to view and inspect the DataFrame.
22. Use methods like **loc[]**, **iloc[]**, and boolean indexing to select rows and columns of the DataFrame.
23. Perform time series operations like resampling, shifting, and rolling window calculations.
24. Group data using **groupby()** and perform aggregation operations like **sum()**, **mean()**, **count().**

SEMESTER-II

Name of the Course	Machine Learning		
Course Code	**MSAI-201**	Credits-4	L-4, T-0, P-0
Lectures to be Delivered	60 (1 Hr Each) (L=60, T=0for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Explain the principles of supervised and unsupervised learning, and differentiate between various machine learning techniques.
CO2	Design and implement classification and regression models, evaluating their performance using appropriate metrics.
CO3	Utilize ensemble learning methods and dimensionality reduction techniques to enhance machine learning models.
CO4	Apply clustering algorithms to unsupervised learning problems, including anomaly detection.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-201 Machine Learning

UNIT-I

The Machine Learning Landscape: What is Machine learning and why use machine learning, types of machine learning systems, Supervised and Unsupervised learning, Instants based vs Models based, Challenges in Machine Learning, Testing and Validation.

Classification: MNIST, Training a binary classifier, performance measures: measuring accuracy using cross validation, confusion matrix, precision and recall, precision/recall trade off, the ROC curve, multiclass classification, error analysis, multilevel classification, multioutput classification.

UNIT-II

Training Models using Regression: Linear Regression, Gradient Descent: Batch, Stochastic, Mini-Batch, Polynomial Regression, Learning Curves, Regularized Linear Models: Rideg Regression, Lasso Regression, Elastic Net, Early Stopping, Logistic Regression: Estimating Probabilities, Training and Cost Function, Decision Boundaries, Softmax Regression.

Support Vector Machines: Linear SVM, Softmargin Classification, Non Linear Classification: Polynomial Kernel, Adding Similarity Features, Gaussian RBF Kernel, Computational Complexity, SVM Regression.

Decision Trees: Training and Visualizing a Decision Tree, Making Predictions, Estimating Class Probabilities, The CART Training Algorithm, Computational Complexity, Gini Impurity or Entropy, Regularization Hyperparameters, Regression.

UNIT-III

Ensemble Learning and Random Forests: Voting Classifiers, Bagging and Pasting: Bagging and Pasting in Scikit-Learn, Out of Bag Evaluation, Random Patches and Random Subspaces, Random Forest:Extra –Trees, Feature Importance, Boosting:AdaBoost, Gradient Boosting, Stacking.

Dimensionality Reduction: The Curse of Dimensionality, Main Approaches for Dimensionality Reduction: Projection, Manifold Learning, PCA: Preserving the Variance, Principal Components, Projecting Down tod Dimensions, Using Scikit-Learn, Explained Variance Ratio, Choosing the Right Number of Dimensions, PCA for Compression, Randomized PCA, Incremental PCA, Kernel PCA: Selecting a Kernel and Tuning Hyperparameters, LLE.

UNIT-IV

Unsupervised Learning Techniques: Clustering: K-Means, Limit of K-means, Using clustering for image segmentation, Using Clustering for Preprocessing, Using Clustering for Semi-Supervised Learning, DBSCAN, Other Clustering Algorithms, Gaussian Mixtures: Anomaly Detection using Gaussian Mixtures, Selecting the Number of Clusters, Bayesian Gaussian Mixture Models, Other Anomaly Detection and Novelty Detection Algorithms.

Text Books:

1. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 3rd Edition, O'Reilly Media, 2022**.**
2. Alpaydin, Ethem. Introduction to Machine Learning, Prentice Hall Indian Learning Pvt. Ltd.,4th edition,2020.

Reference Books:

1. James Gareth, Daniela Witten, Trevor Hastie, Robert Tibshirani, An Introduction to Statistical Learning: With Applications in R. Germany, Springer New York, 2nd edition, 2021.

2. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 4th edition,2020.
3. Murphy, Kevin P. Machine Learning: A Probabilistic Perspective. Prentice Hall Indian Learning Pvt. Ltd.,2nd edition,2022.
4. Simon O. Haykin, Neural Networks and Learning Machines, Pearson Education,3rd edition, 2009.

Name of the Course	Big Data Analytics and Data Visualization		
Course Code	**MSAI-202**	Credits-4	L-4, T-0, P-0
Lectures to be Delivered	60(1 Hr Each) (L=60, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Explain the principles of big data, its characteristics, and the technologies used for storage and analysis (Hadoop, nosql).
CO2	Design big data solutions using mapreduce, Hive, Pig, and Spark, demonstrating an understanding of data processing and analytics.
CO3	Acquire, process, and visualize data using Python libraries (Matplotlib, Seaborn, D3.js).
CO4	Create effective data visualizations with Python, employing various chart types, plot customizations, and interactive elements.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-202 Big Data Analytics and Data Visualization

UNIT-I

Introduction: Introduction to Big Data Analytic, Big Data, Scalability and Parallel Processing, Designing Data Architecture, Data Sources, Quality, Pre-Processing and Storing, Data storage and Analysis, Big Data Analytics Applications and Case Studies.

Introduction to Hadoop: Hadoop and its Ecosystem, Hadoop Distributed File System, Hadoop yarn, Hadoop Ecosystem Tools.

NoSQL Big Data Management: Introduction to NoSQL, NoSQL Data Store, NoSQL Data Architecture Patterns, NoSQL to Manage Big Data, Shared-Nothing Architecture for Big Data Tasks; MongoDB Database.

UNIT-II

MapReduce, Hive and Pig: Introduction, MapReduce Map Tasks, Reduce Tasks, and MapReduce Execution, Composing MapReduce for Calculations and Algorithms, Hive, HiveQL, Pig.

Spark and Big Data Analytics: Introduction, Spark, Introduction to Data Analysis with Spark, Downloading Spark, and Programming using RDDs and MLIB, Data ETL (Extract, Transform and Load) Process, Introduction to Analytics, Reporting and Visualizing.

UNIT-III

Introduction to Data Visualization with Python: Acquiring and Visualizing Data, Heavyweight Scraping with Scrapy , Simultaneous acquisition and visualization, Applications of Data Visualization, Keys factors of Data Visualization. Exploring the Visual Data Spectrum: Charting Primitives (Data Points, Line Charts, Bar Charts, Pie Charts, Area Charts), Pairwise data, Matplotlib Statistical distributions: (hist(x), boxplot(x), errorbar, violinplot, eventplot, hist2d, hexbin, ecdf), Gridded data, Irregularly gridded data: (tricontour, tricontourf, tripcolor, triplot), 3D and volumetric data, Lines, bars and markers, Subplots, axes and figures, Pie and Polar charts, Text, labels, and annotations, shapes and collections, Exploring Advanced Visualizations (Candlestick Charts, Bubble Charts, Surface Charts, Map Charts, Infographics).

Visualizing Data with Matplotlib: Introduction, Architecture, Elements, High Level Plotting-Historical Background, Pyplot and Object-Oriented Matplotlib, Starting an Interactive Session, Interactive Plotting with Pyplot's Global State: Configuring Matplotlib, Setting the Figure's Size, Points, Not Pixels, Labels and Legends, Titles and Axes Labels, Saving your Charts, Figures and Object-oriented Matplotlib, Plot Types, Matplotlib, NetworkX, , New Styles in Matplotlib, Seaborn; Data Analysis - SciPy & Seaborn.

UNIT-IV

Visualizing Data with D3: Imagining a Nobel Visualization, Building a Visualization: HTML skeleton, CSS styling, The JavaScript Engine, Introducing D3: framing the problem, working with selections, adding DOM elements, Leveraging D3, Measuring up with D3's Scales, unleashing the power of D3 with data binding, the enter method, accessing the bound data, the update pattern, axes and labels, transitions, Visualizing Individual Prizes, Mapping with D3: Available Maps, D3's Mapping Data formats, D3 Geo, projections, and paths, putting elements together, updating the map, adding value indicators.

Text Books:

1. Raj Kamal and Preeti Saxena, Big Data Analytics: Introduction to Hadoop, Spark, and Machine-Learning, McGraw-Hill Education, 2019.
2. Kyran Dale, Data Visualization with Python and JavaScript, O'Reilly, 2nd Edition, 2022.

3. Scott Murray, Interactive Data Visualization for Web, O'Reilly,2nd edition, 2017.

Reference Books:

1. Jon Raasch, Graham Murray, Vadim Ogievetsky, Joseph Lowery, "JavaScript and jQuery for Data Analysis and Visualization", WROX,2014.
2. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
3. P. J. Sadalage, M. Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Addison-Wesley Professional, 2012.
4. Ritchie S. King, Visual story telling with D3" ,Pearson, 2015.
5. Ben Fry, Visualizing data: Exploring and explaining data with the processing environment, O'Reilly, 2007.
6. A Julie Steele and Noah Iliinsky, Designing Data Visualizations: Representing Informational Relationships, O'Reilly, 2011.
7. Andy Kirk, Data Visualization: A Successful Design Process, Packt, 2012.
8. Nathan Yau, Data Points: Visualization that means something, Wiley, 2013.

Name of the Course	**Introduction to Computer Vision and Image Processing**		
Course Code	**MSAI-203**	Credits-4	L-4, T-0, P-0
Lectures to be Delivered	60 (1 Hr Each) (L=60, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Explain the core concepts of digital image processing, including acquisition, representation, and transformations.
CO2	Apply image enhancement, compression, and morphological processing techniques for various image manipulation tasks.
CO3	Perform image segmentation to identify and isolate objects or regions of interest within images
CO4	Utilize fundamental computer vision principles, including motion analysis, 3D reconstruction, and image-based rendering.
CO5	Apply concepts of computer vision to solve problems related to object recognition and scene understanding.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-203 Introduction to Computer Vision and Image Processing

UNIT-I

Introduction and Digital Image Fundamentals: Applications of digital image processing, Fundamental steps in digital image processing, Image sensing and acquisition, image sampling and quantization, basic relationships between pixel, Gray level transformations.

Image Enhancement in The Spatial Domain and Frequency Domain: Histogram Processing, local enhancement, image subtraction, image averaging, Fundamentals of Spatial Filtering,

smoothing and sharpening spatial filters, Discrete Fourier transformation, filtering in the frequency domain, image smoothing using Lowpass Frequency Domain filters and image sharpening using Highpass filters, Noise Models, Restoration in the presence of Noise Only- Spatial filtering, Periodic Noise Reduction using Frequency Domain Filtering, Image Reconstruction from Projections.

UNIT-II

Image Compression and Watermarking: Fundamentals, Huffman Coding, Golomb Coding, Arithmetic Coding, LZW Coding, Run-length Coding, Symbol-Based Coding, Bit-plane Coding, Block Transform Coding, Predictive Coding.

Morphological Image Processing: Erosion and dilation, opening and closing, hit-or-miss transformation, some basic morphological algorithms, Morphological Reconstruction.

Image Segmentation: Point, line and edge detection, gradient operator, edge linking and boundary detection, thresholding, region-based segmentation, representation schemes like chain codes, polygonal approximations, boundary segments, skeleton of a region, boundary descriptor.

UNIT-III

Introduction to Computer Vision and Motion Representation: Image Formation, Feature based alignment, 2D and 3D feature based alignment, Pose estimation, geometric intrinsic calibration, Triangulation, two frame structure from motion, factorization, bundle adjustment, Translation alignment, parametric motion, spline based motion, optical flow, layered motion.

Computation Photography: Photometric calibration, high dynamic range imaging, super-resolution and blur removal, image matting and composing, Texture analysis and synthesis.

UNIT-IV

3D Reconstruction and Image-Based Rendering: Shape from X, Active rangefinding, Surface representations, point-based representations, volumetric representations, model-based reconstruction, recovering texture maps and albedos, layered depth images, light fields and lumigraphs.

Recognition: object detection, face recognition, instance recognition, category recognition, context and scene understanding, recognition databases and test sets.

Text Books:

1. Rafael C. Gonzalez and Richard E.Woods, Digital Image Processing (4th edition), Prentice–Hall of India, 2016.
2. Richard Szeliski, Computer Vision: Algorithms and Applications (2nd edition),Springer,2022.

Reference Books:

1. Bernd Jahne, Digital Image Processing, (7th edition), Springer, 2022.
2. M.A. Joshi, Digital Image Processing: An Algorithmic Approach (2nd edition), Prentice-Hall of India,2021.
3. B. Chandra and D.D. Majumder, Digital Image Processing and Analysis, Prentice-Hall of India, 2011.
4. Reinhard Klette, Concise Computer Vision: An Introduction into Theory and Algorithms, Springer,4th edition, 2022.
5. E.R. Davies, Computer Vision: Principles, Algorithms, Applications, Learning(5th edition), 2017.

Name of the Course	Optimization Techniques		
Course Code	**MSAI-204**	Credits-3	L-3, T-0, P-0
Lectures to be Delivered	45 (1 Hr Each) (L=45, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Define optimization problems, differentiate between constrained and unconstrained problems, and explain conditions for finding optimal solutions.
CO2	Apply various optimization techniques, including one-dimensional search methods, gradient methods, and the Simplex Method for linear programming.
CO3	Solve optimization problems with equality and inequality constraints using appropriate methods.
CO4	Explain the principles of convex optimization and apply them to solve relevant problems.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-204 Optimization Techniques

UNIT-I

Basics of Set-Constrained and Unconstrained Optimization: Introduction, Conditions for Local Minimizers. One-Dimensional Search Methods: Introduction, Golden Section Search, Fibonacci Method, Bisection Method, Newton's Method, Secant Method, Bracketing. Line Search in Multidimensional Optimization.

Gradient Methods: Introduction, The Method of Steepest Descent, Analysis of Gradient Methods.

UNIT-II

Linear Programming: Brief History of Linear Programming, Simple Examples of Linear Programs, Two-Dimensional Linear Programs, Convex Polyhedra and Linear Programming, Standard Form Linear Programs, Basic Solutions, Properties of Basic Solutions, Geometric View of Linear Programs.

Simplex Method: Solving Linear Equations Using Row Operations, The Canonical Augmented Matrix, Updating the Augmented Matrix, The Simplex Algorithm, Matrix Form of the Simplex Method, Two-Phase Simplex Method, Revised Simplex Method. Duality: Dual Linear Programs, Properties of Dual Problems.

UNIT-III

Problems with Equality Constraints: Introduction, Problem Formulation, Tangent and Normal Spaces, Lagrange Condition, Second-Order Conditions, Minimizing Quadratics Subject to Linear Constraints.

Problems with Inequality Constraints: Karush-Kuhn-Tucker Condition, Second-Order Conditions. Convex Optimization Problems: Introduction, Convex Functions, Convex Optimization Problems, Semidefinite Programming.

UNIT- IV

Algorithms for Constrained Optimization: Introduction, Projections, Projected Gradient Methods with Linear Constraints, Lagrangian Algorithms, Penalty Methods.

Multiobjective Optimization: Introduction, Pareto Solutions, Computing the Pareto Front, From Multiobjective to Single-Objective Optimization, Uncertain Linear Programming Problems.

Text Books:

1. Edwin K.P. Chong, Stanislaw H. Zak, An Introduction to Optimization, Wiley, 4th edition, 2017.

Reference Books:

1. Hamdy A. Taha, Operations Research – An Introduction, 10th Edition, Pearson Education , 2017.

Name of the Course	Big Data Analytics and Data Visualization Lab		
Course Code	**MSAI-251**	Credits-2	L-0, T-0, P-4
Lectures to be Delivered	**60 Hours of Lab Sessions**		
Semester End Examination	**Max Marks: 50**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Set up a Big Data environment (Hadoop, cloud-based service) and demonstrate proficiency in ingesting, storing, and transforming large datasets.
CO2	Perform data cleaning and preprocessing tasks on large datasets using scalable tools like Apache Spark.
CO3	Design and implement machine learning algorithms to solve real-world problems using Big Data frameworks.
CO4	Create effective visualizations to present insights gleaned from large datasets, using tools like Tableau or D3.js.
CO5	Analyze scalability and performance considerations in a Big Data context, optimizing code to handle massive datasets.

MSAI-251 Big Data Analytics and Data Visualization Lab

1: Data Ingestion and Storage

- Set up a Hadoop cluster or use a cloud-based Big Data service.
- Ingest a large dataset (e.g., CSV or JSON format) into the Hadoop Distributed File System (HDFS).
- Explore different storage formats (e.g., Parquet, ORC) and analyze the impact on storage size and query performance.
- Write MapReduce or Spark code to perform basic data transformations and store the processed data in a NoSQL database (e.g., MongoDB).

2: Data Preprocessing and Cleaning

- Choose a large dataset from a public repository (e.g., Kaggle).

- Apply data cleaning techniques such as handling missing values, outliers, and noise.
- Use Apache Spark or a similar framework to parallelize the data processing tasks.
- Split the dataset into training and testing sets for future analysis.

3: Data Analysis and Mining

- Select a real-world dataset related to a specific domain (e.g., customer churn prediction, fraud detection).
- Implement a machine learning algorithm (e.g., decision tree, logistic regression) using Apache Mahout or a similar library.
- Split the dataset into training, validation, and testing sets.
- Evaluate the performance of the model using appropriate performance metrics (e.g..., accuracy, precision, recall).

4: Data Visualization

- Choose a large dataset with multiple dimensions and attributes.
- Use a visualization tool like Tableau or D3.js to create interactive visualizations.
- Explore different visualization techniques, such as histograms, scatter plots, and heatmaps.
- Present your findings and insights in a visually appealing and informative manner.

5: Scalability and Performance Optimization

- Scale up your analysis from Assignment 3 to handle larger datasets.
- Evaluate the performance of the Big Data platform in terms of processing time and resource utilization.
- Identify bottlenecks and optimize the code (e.g., using data partitioning, caching) to improve performance.
- Compare the performance of different hardware configurations or cloud-based services for Big Data analytics.

6: Case Study and Application

- Choose an industry or domain of interest (e.g., healthcare, finance, marketing).
- Identify a specific problem or challenge in that domain that can be addressed using Big Data analytics.
- Gather relevant datasets and perform exploratory data analysis.
- Apply appropriate data analysis and mining techniques to derive insights and solutions.

- Present your findings and recommendations in a comprehensive report or presentation.

Name of the Course	Machine Learning Lab		
Course Code	**MSAI-252**	Credits-2	L-0, T-0, P-4
Lectures to be Delivered	**60 Hours of Lab Sessions**		
Semester End Examination	**Max Marks: 50**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	apply data visualization techniques to explore relationships within datasets and identify potential patterns.
CO2	perform data preprocessing, including handling missing values and transforming categorical features for machine learning.
CO3	implement and evaluate linear regression models (simple, multiple, polynomial) for predictive tasks.
CO4	design and apply classification algorithms (Naive Bayes, Decision Trees, SVM) for various problem types.
CO5	utilize dimensionality reduction techniques (e.g., PCA) to address high-dimensional data.
CO6	implement and analyze clustering algorithms (K-means, Agglomerative) for unsupervised learning tasks.

MSAI-252 **Machine Learning-Lab**

1. Write a Python program to prepare a Scatter Plot (Use Forge Dataset / Iris Dataset).
2. Write a Python program to find all null values in a given data set and remove them.
3. Write a Python program the Categorical values in numeric format for a given dataset.
4. Write a Python program to implement simple Linear Regression for predicting House-price.
5. Write a Python program to implement multiple Linear Regression for a given dataset.
6. Write a Python program to implement Polynomial Regression for the given dataset.
7. Write a Python program to Implement Naïve Bayes.
8. Write a Python program to Implement Decision Tree whether or not to play tennis.

9. Write a Python program to implement linear SVM.

10. Write a Python program to transform data with Principal Component Analysis (PCA).

11. Write a Python program to implement the k-nearest Neighbors ML algorithm to build prediction model (Use Forge Dataset).

12. Write a Python program to implement the k-means algorithm on a synthetic dataset.

13. Write a Python program to implement Agglomerative clustering on a synthetic dataset.

ELECTIVE-1

Name of the Course	**Database Management System**		
Course Code	**MSAI-EL-211**	Credits-3	L-3, T-0, P-0
Lectures to be Delivered	45(1 Hr Each) (L=45, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Explain the fundamental concepts of database management systems.
CO2	Design and construct database schemas using the entity-relationship model and translate them into relational tables.
CO3	Utilize SQL to create, manipulate, and query relational databases, including advanced concepts.
CO4	Apply normalization principles to optimize database design and understand functional dependencies.
CO5	Analyze transaction processing, concurrency control, and recovery techniques to ensure database integrity and consistency.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-EL-211 Database Management System

UNIT-I

Basic Concepts: File Systems vs. DMBS, Characteristics of the Data Base Approach, Abstraction and Data Integration, Database users, Advantages and Disadvantages of a DBMS.

Data Base Systems Concepts and Architecture: Schema and Instances, DBMS architecture and Data Independence, database languages and Interfaces, DBMS functions and component modules, Centralized and Client/Server Architectures for DBMS, Data Models.

Entity Relationship Model: Entity Types, Entity Sets, Attributes & keys, Relationships, Relationships Types, Roles and Structural Constraints, Design issues, E-R Diagrams, Design of an E-R Database Schema, Reduction of an E-R schema to Tables.

UNIT-II

Relational Data Model: Relational model concepts, Integrity constraints over Relations, Relational Algebra– Basic Operations, Relational Calculus, Codd Rules.

SQL: Data Definition and Data Types, Components of SQL: DDL, DML, and DCL, Schema Change Statement in SQL, Views, Joins& Queries in SQL, Specifying Constraints & Indexes in SQL, Database Triggers, SQL Injection.

UNIT- III

Relational Data Base Management System: RDBMS, Basic structure, Date Base Structure & its manipulation in an RDBMS, Storage Organization. Conventional Data Models: An Overview of Network and Hierarchical Data Models.

Relational Data Base Design: Functional Dependencies, Decomposition, Normal forms based on primary keys (1 NF, 2 NF, 3 NF, & BCNF), Multi-valued Dependencies, 4 NF, Join dependencies, 5 NF, Algorithms for Query Processing and Optimization.

UNIT-IV

Transaction Processing Concepts: Introduction to Transaction Processing, Transaction & System Concepts, Properties of Transaction, Schedules and Recoverability, Serializability of Schedules. **Concurrency Control Techniques:** Locking Techniques, Time stamp ordering, Multi-version Techniques, Optimistic Techniques, Granularity of Data items.

Recovery Techniques: Recovery concepts, Recovery and Atomicity, Recovery Algorithm, ARIES, Recovery in Multi database Systems, Remote Backup Systems.

Text Books:

1. Elmasri & Navathe, Fundamentals of Database systems, Pearson Education,7th edition, 2017.
2. Korth & Silberschatz, Database System Concept, McGraw Hill International Edition,7th edition, 2019.

Reference Books:

1. Hector Garcia-Molina, Jeffrey D. Ullman, and Jennifer Widom, Database Systems: The Complete Book,Pearson,3rd edition, 2014.
2. Ivan Bayross, SQL, PL/SQL- The Program Language of ORACLE, BPB Publication,3rd revised edition, 2010.

3. Raghu Ramakrishnan& Johannes Gehrke, Database Management Systems, Mcgraw Hill,3rd edition,2003.
4. Peter Rob, Carlos Colonel, Database system Design, Implementation, and Measurement, Cengage Learning,13th edition,2019.
5. Alexis Leon & Mathews Leon: Database Management System, Leon Vikas Publication,2008.

Name of the Course	**Information Retrieval**		
Course Code	**MSAI-EL-212**	Credits-3	L-3, T-0, P-0
Lectures to be Delivered	45 (1 Hr Each) (L=45, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 Hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Explain fundamental concepts of information retrieval.
CO2	Apply probabilistic and vector space models for document representation and retrieval.
CO3	Describe modern search engine architectures, including indexing, crawling, and ranking techniques.
CO4	Implement components of a search engine, demonstrating practical understanding of indexing, query processing, and ranking techniques.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-EL-212 Information Retrieval

UNIT- 1

Introduction to Information Retrieval: Scope, goals, and applications. Historical perspectives of IR, Boolean Retrieval Model: Set theory concepts, inverted indices, query processing.

Information Needs and Relevance: Defining user queries, the concept of relevance, challenges in its measurement, Basic Evaluation Measures: Precision, recall, F-measure, mean average precision.

UNIT -II

Probabilistic Retrieval Models: Understanding uncertainty in relevance, ranking documents based on probability, the Binary Independence Model, Vector Space Model and tf-idf Weighting: Representing documents and queries as vectors, cosine similarity, term frequency-inverse document frequency.

Term Weighting Schemes: Variations on tf-idf, normalization, advanced weighting for better retrieval, Latent Semantic Indexing (LSI): Dimensionality reduction, uncovering hidden relationships between terms and documents.

UNIT- III

Indexing: Efficient index construction techniques, compression methods, handling dynamic updates, Web Crawling: Building a web crawler, focused crawling, challenges of web-scale data collection.

Search Engine Architecture: Components, query processing pipelines, distributed and parallel retrieval, Link Analysis and Ranking: PageRank algorithm, HITS, combating link spam.

UNIT -IV

Advanced Evaluation Techniques: Test collections, A/B testing, interleaved comparisons, beyond precision/recall, User Interfaces and Visualization: Search result presentation, search engine result pages (SERPs), visualizing retrieval results.

Text Classification and Clustering: Document categorization, clustering techniques for search result organization, Emerging Trends: Personalized search, question answering systems, conversational IR.

Text Book:

1. Stefan Buettcher, Charles L.A. Clarke, Gordon V. Cormack, Information Retrieval: Implementing and Evaluating Search Engines, MIT Press, 2016.

Reference Books:

1. Christopher D. Manning, Prabhakar Raghavan, and Hinrich Schütze,**"Introduction to Information Retrieval"** , Cambridge University Press, 2008.
2. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, **"Modern Information Retrieval**" The Concepts and Technology Behind Search" , ACM Press, 1999.

Name of the Course	Software Engineering		
Course Code	**MSAI-EL-213**	Credits-3	L-3, T-0, P-0
Lectures to be Delivered	45(1 Hr Each) (L=45, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 Hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Explain software engineering principles, analyze software development lifecycles, and select appropriate models.
CO2	Perform requirements analysis and create software specifications.
CO3	Design software architectures applying functional and object-oriented principles.
CO4	Utilize software maintenance, configuration management, and the importance of software certification.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-EL-213 Software Engineering

UNIT- I

Introduction: Software Engineering, Changing nature of Software, Software Myths, Terminologies, Role of management in software development Software Process and desired Characteristics, Software Life Cycle Models: Build & Fix Model, Water Fall Model, Incremental Process Model, Evolutionary Process Models, Unified Process, Comparison of Models, Other Software Processes, Selection of a Model Software Requirements Analysis & Specifications: Requirements Engineering, Types of Requirements, Feasibility Studies, Requirements Elicitation, Requirements - Analysis Documentation, Validation and Management.

UNIT - II

Software Architecture: Its Role, Views, Component & Connector View and its architecture style, Architecture Vs Design, Deployment View & Performance Analysis, Documentation, Evaluation Software Project Planning: Size estimation, Cost Estimation, COCOMO, COCOMO – II, Software Risk Management.

UNIT - III

Function Oriented Design: Design principles, Module level Concepts, Notation & Specification, Structured Design Methodology, Verification Object-Oriented Design: OO Analysis & Design, OO Concepts, Design Concepts, UML – Class Diagram, Sequence & Collaboration Diagram, Other diagrams & Capabilities, Design Methodology – Dynamic and Functional Modeling, Internal Classes & Operations Detailed Design: PDL, Logic/Algorithm Design, State Modeling of Classes, Verification – Design Walkthroughs, Critical Design Review, Consistency Checkers.

UNIT- IV

Coding: Programming Principles & Guidelines, Coding Process, Refactoring, Verification Software Metrics: What & Why, Token Count, Data Structure Metrics, Information Flow Metrics, Object-Oriented Metrics, Use Case Oriented Metrics, Web Engineering Project Metrics, Metric Analysis Software Maintenance & Certification: Maintenance, Maintenance Process and Models, Estimation of Maintenance Costs, Regression Testing, Reverse Engineering, Software Re-engineering, Configuration Management, Documentation, Requirements of Certification, Types.

Text Books:

1. K.K. Aggrawal and Yogesh Singh, “Software Engineering”, 3rd Edition, New Age International (P) Ltd, 2008.
2. Pankaj Jalote, “An Integrated Approach to Software Engineering”, 3rd Edition, Narosa Publishing House, 2005.

Reference Books:

1. Pressman, R.S., “Software Engineering – A Practitioner's Approach”, Third Edition, McGraw Hills, 2008.

SEMESTER-III

Name of the Course	Deep Learning		
Course Code	**MSAI-301**	Credits-4	L-4, T-0, P-0
Lectures to be Delivered	60 (1 Hr Each) (L=60, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Explain the principles of deep learning, including its foundations, neural network architectures, and optimization techniques.
CO2	Design and implement feedforward and convolutional neural networks (cnns) for various deep learning tasks.
CO3	Construct and apply recurrent neural networks (rnns), including advanced architectures like LSTM, for sequence modeling.
CO4	Utilize autoencoders for unsupervised learning, dimensionality reduction, and representation learning.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Sections A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 16% of the total marks of the semester-end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-301 Deep Learning

UNIT-I

Introduction: Historical context and motivation for deep learning, biological neurons, neural networks, artificial neural networks, linear perceptron, perceptron learning algorithm.

Applied maths and ML basics: scalars, vectors, matrices, and tensors, multiplying matrices and vectors, special kinds of matrices and vectors, principal components analysis, probability distribution, conditional probability, independence, and conditional independence, expectation, variance and covariance.

UNIT-II

Neural Networks: Feedforward neural networks, deep networks, regularizing a deep network, model exploration, and hyperparameter tuning.

Convolution Neural Networks: Introduction to convolution neural networks: stacking, striding and pooling, applications like image, and text classification.

UNIT-III

Sequence Modeling: Recurrent Nets: Unfolding computational graphs, recurrent neural networks (RNNs), bidirectional RNNs, encoder-decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, echo state networks, LSTM, and other gated RNNs.
Autoencoders: Undercomplete autoencoders, regularized autoencoders, sparse autoencoders, denoising autoencoders, representational power, layer, size, and depth of autoencoders, stochastic encoders, and decoders.

UNIT-IV

Structured probabilistic Models for Deep Learning: The challenge of unstructured modeling, using graphs to describe model structure, sampling from graphical models, Advantages of structured modeling, learning about dependencies, inference, and approximate inference, the deep learning approach to structured probabilistic models.

Text Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016.
2. Jeff Heaton, Deep Learning and Neural Networks, Heaton Research Inc, 2015.

Reference Books:

1. Mindy L Hall, Deep Learning, VDM Verlag, 2011.
2. Li Deng (Author), Dong Yu, Deep Learning: Methods and Applications (Foundations and Trends in Signal Processing), Now Publishers Inc, 2014.

Name of the Course	Natural Language Processing		
Course Code	**MSAI-302**	Credits-4	L-4, T-0, P-0
Lectures to be Delivered	60 (1 Hr Each) (L=60, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Explain the fundamental concepts of natural language processing, its applications, and the challenges of analyzing natural language.
CO2	Design, implement, and evaluate parsing algorithms using various grammatical formalisms.
CO3	Construct semantic representations of natural language, addressing issues like ambiguity, thematic roles, and logical forms.
CO4	Apply machine translation techniques, build encoder-decoder models, and address linguistic challenges in multilingual contexts.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Sections A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 16% of the total marks of the semester-end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-302 Natural Language Processing

UNIT-I

Introduction to Natural language Processing: The Study of Language, Applications of NLP, Evaluating Language Understanding Systems, Different Levels of Language Analysis, Representations and Understanding, Organization of Natural language Understanding Systems, Linguistic Background: An outline of English Syntax, Elements of Simple Noun Phrases, The Elements of Simple Sentences, Prepositional Phrases, Embedded Sentences, Complements, Adjective Phrases.

UNIT-II

Grammars and Parsing: Grammars and Parsing- Top- Down and Bottom-Up Parsers, Transition Network Grammars, Feature Systems and Augmented Grammars, Morphological Analysis and the Lexicon, Parsing with Features, Augmented Transition Networks.

Grammars for Natural Language: Grammars for Natural Language, Movement Phenomenon in Language, Handling questions in Context Free Grammars, Hold Mechanisms in ATNs, Gap Threading, Human Preferences in Parsing, Shift Reduce Parsers, Deterministic Parsers.

UNIT-III

Semantic Interpretation: Semantic & Logical form, Word senses & ambiguity, The basic logical form language, Encoding ambiguity in the logical Form, Verbs & States in logical form, Thematic roles, Speech acts & embedded sentences, Defining semantics structure model theory.

Language Modeling: Introduction, n-Gram Models, Language model Evaluation, Parameter Estimation, Language Model Adaption, Types of Language Models, Language-Specific Modeling Problems, Multilingual and Cross-lingual Language Modeling, Neural Networks and Neural Language Models, Feedforward networks for NLP, RNNs as Language Models, RNNs for other NLP tasks, The LSTM, Transformers as Language Models.

UNIT-IV

Machine Translation and Encoder-Decoder Models: Introduction, Problems of Machine Translation, Is Machine Translation Possible, Machine Translation Evaluation, Word Alignment, Phrase-Based Models, Tree-Based Models, Linguistic Challenges, Language Divergences and Typology, The Encoder-Decoder Model, Beam Search, Encoder-Decoder with RNNs and Transformers, MT Systems.

Multilingual Information Retrieval: Introduction, Document Preprocessing, Monolingual Information Retrieval, CLIR, MLIR, Evaluation in Information Retrieval, Tools, Software and Resources.

Combining Natural Language Processing Engines: Introduction, Desired Attributes of Architectures for Aggregating Speech and NLP Engines, Architectures for Aggregation, Case Studies, Lessons Learned.

Text Books:

1. James Allen, Natural Language Understanding, 2nd Edition, 2003, Pearson Education.
2. Daniel Jurafsky and James H., Speech and Language Processing, 3rd Edition, Martin Prentice Hall,2024.
3. Daniel M.Bikel and Imed Zitouni , Multilingual Natural Language Processing Applications : From Theory To Practice, IBM Press,2012.

Reference Books:

1. Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.
2. Akshar Bharathi,Vineet chaitanya,Natural Language Processing, A paninian perspective, Prentice –Hall of India, 2008.
3. Jurafsky, Dan and Martin, James, Speech and Language Processing, 2nd Edition, Pearson Education, 2014.
4. Manning, Christopher and Henrich, Schutze, Foundations of Statistical Natural Language Processing, MIT Press, 1999.

Name of the Course	**Advances in AI**		
Course Code	**MSAI-303**	Credits-4	L-4, T-0, P-0
Lectures to be Delivered	60(1 Hr Each) (L=60, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Explain the fundamental concepts and recent advancements in Large Language Models (LLMs) and Transformer architectures.
CO2	Describe the principles and applications of Generative AI and Multimodal learning in various creative and analytical tasks.
CO3	Analyze the applications of AI in specialized domains and discuss the importance of Explainable AI (XAI) in critical systems.
CO4	Evaluate the concepts of Artificial General Intelligence (AGI) and discuss ethical considerations in AI development and deployment.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Sections A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 16% of the total marks of the semester-end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-303 Advances in AI

UNIT-I

History and Evolution of AI: Overview of AI development from early rule-based systems to neural networks and deep learning. Key milestones in AI research and developmentt.

Recent Breakthroughs in AI: GPT and Large Language Models (LLMs), Vision Transformers (ViT) and their application in image processing. Reinforcement Learning advancements (Deep Q-Networks, AlphaGo, etc.).

AI Frameworks and Libraries: TensorFlow, PyTorch, Hugging Face, and other essential tools for building AI models.

UNIT-II

Advanced Neural Networks: Convolutional Neural Networks (CNNs) for image classification, Recurrent Neural Networks (RNNs), LSTMs, and Transformer models for sequence tasks.
Generative Models: Generative Adversarial Networks (GANs), Variational Autoencoders (VAEs), Applications in image generation and synthetic data creation.
Reinforcement Learning (RL): Deep RL concepts: Policy gradients, Q-learning, Applications of RL in game theory, robotics, and autonomous systems.

UNIT-III

Healthcare AI: AI in medical imaging, diagnosis, and drug discovery, Ethical considerations in AI-driven healthcare.
AI in Finance and Business: AI for financial prediction and fraud detection, AI-driven decision-making in business analytics.
Autonomous Systems: Self-driving cars and drones- AI applications in real-time decision-making, AI in robotics and industrial automation.

UNIT-IV

AI in Natural Language Processing (NLP): Advancements in multilingual NLP and transfer learning with LLMs, Chatbots and virtual assistants.
Ethics and Explainability in AI: Challenges in making AI models interpretable and trustworthy, Societal impact and ethical issues in AI deployment.
AI for Social Good: AI's role in tackling climate change, improving education, and enhancing public safety.
Future of AI: AI and quantum computing, Artificial General Intelligence (AGI) vs. Narrow AI.

Textbooks:

1. Russell, Stuart and Norvig, Peter, **"Artificial Intelligence: A Modern Approach"**, Pearson, 4th Edition, 2020.
2. Sutton, Richard S. and Barto, Andrew G., **"Reinforcement Learning: An Introduction"**, MIT Press, 2nd Edition, 2018.
3. Géron, Aurélien, **"Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow"**, O'Reilly Media, 2nd Edition, 2019.
4. Rothman, Denis, **"Transformers for Natural Language Processing"**, Packt Publishing, 2nd Edition, 2022.

Reference Books:

1. Goodfellow, Ian, Bengio, Yoshua, and Courville, Aaron, **"Deep Learning"**, MIT Press, 2016.
2. Nielsen, Michael, **"Neural Networks and Deep Learning"**, Determination Press, 2015 (Available online).
3. Molnar, Christoph, **"Interpretable Machine Learning"**, Leanpub, 2nd Edition, 2022.

4. Barredo Arrieta, Alejandro, et al., **"Explainable Artificial Intelligence (XAI): Concepts, Taxonomies, Opportunities, and Challenges toward Responsible AI"**, Information Fusion, 2020.
5. Bohr, Adam and Memarzadeh, Kaveh (Eds.), **"Artificial Intelligence in Healthcare"**, Academic Press, 2020.
6. Tegmark, Max, **"Life 3.0: Being Human in the Age of Artificial Intelligence"**, Knopf, 2017.

Name of the Course	**Deep Learning Lab**		
Course Code	**MSAI-351**	Credits-2	L-0, T-0, P-4
Lectures to be Delivered	**60 Hours of Lab Sessions**		
Semester End Examination	**Max Marks: 50**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Design and implement feedforward neural networks to solve classification tasks, demonstrating proficiency with deep learning frameworks.
CO2	Utilize the principles of gradient descent and backpropagation, and implement them to train neural networks.
CO3	Design, train, and evaluate convolutional neural networks (cnns) for image classification tasks.
CO4	Implement recurrent neural networks with LSTM cells for sequence-based tasks like sentiment analysis.

MSAI-351 Deep Learning Lab

1. Implement a basic feedforward neural network using Python and a deep learning framework like TensorFlow or Keras. Train the network on a simple dataset, such as the XOR problem, and analyze the model's performance.
2. Build a multi-layer perceptron (MLP) to classify images from the MNIST dataset. Experiment with different architectures and activation functions to achieve higher accuracy.
3. Implement gradient descent and backpropagation algorithms from scratch in Python to train a simple neural network. Compare the performance with the same model trained using a deep learning framework.
4. Explore the impact of different optimization algorithms (e.g., Adam, RMSprop, SGD) and learning rates on the convergence of a deep neural network.
5. Implement a simple autoencoder using Python and TensorFlow/Keras to perform dimensionality reduction on a dataset.
6. Build a simple feedforward neural network to classify handwritten digits from the MNIST dataset.

7. Experiment with different architectures, activation functions, and optimization algorithms to achieve higher accuracy.
8. Implement a multi-layer perceptron (MLP) neural network from scratch using Python and NumPy. Train the network on a synthetic dataset and visualize the decision boundaries.
9. Design and train a convolutional neural network (CNN) to classify images from the CIFAR-10 dataset. Evaluate the model's performance and analyze common misclassifications.
10. Implement a recurrent neural network (RNN) with Long ShortTerm Memory (LSTM) cells to perform sentiment analysis on a text dataset. Analyze the model's predictions and discuss the importance of sequence modeling.

Name of the Course	Natural Language Processing Lab		
Course Code	**MSAI-352**	Credits-2	L-0, T-0, P-4
Lectures to be Delivered	60 Hrs of Lab Session		
Semester End Examination	**Max Marks: 50**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Pre-process text data (cleaning, normalization) using libraries like NLTK and spaCy.
CO2	Implement bag-of-words and TF-IDF for document representation and explore spelling correction techniques.
CO3	Implement bag-of-words and TF-IDF for document representation and explore spelling correction techniques.
CO4	Apply constituency/dependency parsing, explore word sense disambiguation, and develop sentiment analysis systems.

Natural Language Processing Lab

List of practical:

1. **Text Preprocessing Program**: Write a program that cleans text data from a file. This could involve tasks like removing punctuation, converting to lowercase, removing stop words, and performing stemming/lemmatization. (Libraries: NLTK, spaCy)
2. **Bag-of-Words and TF-IDF:**
   Implement functions to convert text documents into two numerical representations:
   - Bag-of-Words (BoW): Represents a document as a dictionary where keys are words and values are their frequency in the document.
   - TF-IDF (Term Frequency-Inverse Document Frequency): Assigns weights to words based on their importance in a document collection.
3. **Spelling Correction:**
   - Develop an NLP system that can correct spelling errors in a given text.
   - Explore approaches like edit distance, n-grams, and context-based correction.
4. **Language Modeling:**
   - Create a language model using n-gram models or recurrent neural networks(RNNs).
   - Train the model on a large corpus and evaluate its performance.
5. **Part-of-Speech(POS) Tagging**
   - Write a program to perform POS tagging on sentences.
6. **Constituency and Dependency Parsing:**

- Implement constituency parsing(e.g. Using CYK algorithm) and dependency parsing (e.g. using transition-based parsers).

7. **Lexical Semantics:**
   - Investigate word sense disambiguation techniques.
   - Build a system that disambiguates word meanings based on context.
8. **Sentiment Analysis:** Build a sentiment analysis classifier to determine if a piece of text expresses positive, negative, or neutral sentiment.
   Here's the process:
   - Collect a sentiment analysis dataset where each text snippet is labeled as positive, negative, or neutral.
   - Train a machine learning model (e.g., Naive Bayes) on the labeled data.
   - Use the trained model to predict sentiment on new, unseen text data.
   - Evaluate the model's performance using metrics like accuracy, precision, and recall.
     Python Libraries: NLTK, spaCy, scikit-learn
9. **Extractive Text Summarization**:
   - Implement an extractive summarization algorithm that identifies key sentences based on features like sentence position, word frequency, or sentence length.
   - Utilize libraries like NLTK's LexRank algorithm or spaCy's summarization functionality
10. **Text Classification:**
    - Build a text classifier (e.g. sentiment analysis, spam detection) using machine learning algorithms (e.g. Naive Bayes, SVM, neural networks)
    - Train and evaluate the classifier on labeled datasets.

Reference Books:

1. Bird, S., Klein, E., & Loper, E. (2009). Natural language processing with Python (1st ed.). O'Reilly Media.
2. Jurafsky, D., & Martin, J. H. (2021). Speech and language processing (3rd ed.). Pearson.+
3. Goldberg, Y. (2017). Neural network methods for natural language processing (1st ed.). Morgan Kaufmann Publishers

Libraries :

1. NLTK, spaCy, scikit-learn, TensorFlow, Keras(for RNNs).

ELECTIVE-2

Name of the Course	**Data Engineering**		
Course Code	**MSAI-EL-311**	Credits-3	L-3, T-0, P-0
Lectures to be Delivered	45 (1 Hr Each) (L=45, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 Hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Explain the role of data engineering, the data lifecycle, and design data warehouses and data lakes.
CO2	Design ETL processes, perform data cleaning, and apply feature engineering techniques for machine learning.
CO3	Utilize distributed systems and understand Big Data processing and stream processing concepts.
CO4	Work with cloud data platforms, implement data security measures, and understand data governance principles.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-EL-311 Data Engineering

UNIT- I

Role of Data Engineering: Its relationship to data science and AI, critical components of data engineering within an organization, Data Lifecycle: Data generation, collection, ingestion, storage, processing, analysis, visualization, and the ethical considerations surrounding them.

Data Warehousing and Data Lakes: Concepts, design principles, OLAP vs. OLTP, data lake architectures, Databases: Relational (SQL) databases, NoSQL databases (document, columnar, graph), and choosing the right databases for different needs.

UNIT- II

ETL Processes: Extract, Transform, and Load concepts, design patterns, and best practices.

Data Cleaning and Quality: Techniques for identifying and addressing missing values, outliers, errors, inconsistencies, and bias.

Data Wrangling Tools: Introduction to popular tools like Python (Pandas), Spark, R (dplyr, tidyr), or SQL, Feature Engineering: Techniques for creating, selecting, and transforming features to enhance machine learning models.

UNIT - III

Big Data Fundamentals: Defining characteristics of Big Data (Volume, Velocity, Variety), implications for data engineering, Distributed Systems: MapReduce, Hadoop, Spark, architectures, and use cases.

Stream Processing: Concepts of real-time data, processing technologies (Kafka, Flink, Storm), and applications, Data Pipelines: Building robust, fault-tolerant pipelines, workflow orchestration (Airflow, Luigi).

UNIT- IV

Cloud Data Platforms: AWS (S3, Redshift, Glue), Azure (Data Lake Storage, Synapse), Google Cloud (BigQuery, Dataflow), Data Security and Privacy: Encryption, masking, access control, compliance with regulations (GDPR, CCPA).

Data Governance: Establishing data quality rules, lineage, metadata management, and data ownership, DevOps for Data Engineering: CI/CD principles, infrastructure as code (Terraform, etc.), and monitoring.

Text Books:

1. Paul Crickard ,Data Engineering with Python, Packt Publishing, 2020.

2. Liang Zhao, Sherif Sakr, Anna Liu, Athman Bouguettaya,Cloud Data Management, SpringerLink, 2014.

Reference Book:

1. Martin Kleppmann , Designing Data-Intensive Applications, O'Reilly Media, Inc. , 2017.

Name of the Course	Soft computing		
Course Code	**MSAI-EL-312**	Credits-3	L-3, T-0, P-0
Lectures to be Delivered	45 (1 Hr Each) (L=45, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 Hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Explain the principles of soft computing, its advantages, and differentiate it from traditional computing.
CO2	Design and implement fuzzy logic systems, understanding membership functions, operators, and inference for control applications.
CO3	Explain artificial neural network architectures, learning algorithms, and their applications.
CO4	Apply genetic algorithms to solve optimization problems, understanding the principles of selection, crossover, and mutation.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-EL-312 Soft computing

UNIT - I

Introduction to Soft Computing: Definition and Scope of Soft Computing, Applications of Soft Computing in Various Fields, Advantages of Soft Computing over Traditional Computing (e.g., handling uncertainty, learning and adaptation, robustness to errors),Overview of Fuzzy Logic, Neural Networks, and Evolutionary Computation.

UNIT - II

Fuzzy Logic Systems: Fundamentals of Fuzzy Set Theory, Membership Functions and Fuzzy Operators, Fuzzy Reasoning and Inference, Applications of Fuzzy Logic Control Systems (e.g., temperature control systems, robotics),Design and Implementation of Fuzzy Logic Systems .

UNIT- III

Artificial Neural Networks: Introduction to Artificial Neural Networks (ANNs),Structure of Neural Networks: Neurons, Layers, Connections, Learning Algorithms for Neural Networks (e.g., Perceptrons, Backpropagation),Different Network Architectures for Various Tasks (e.g., feedforward, recurrent),Optional: Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs),Applications of Neural Networks in Pattern Recognition, Prediction, and Optimization.

UNIT - IV

Evolutionary Computation: Introduction to Evolutionary Computation, Principles of Genetic Algorithms: Selection, Crossover, Mutation, Applications of Evolutionary Computation in Optimization Problems (e.g., scheduling, resource allocation),Hybrid Soft Computing Approaches: Integration of Fuzzy Logic, Neural Networks, and Evolutionary Computation.

Text Books:

1. S. N. Sivanandam and S. Sumathi , Principles of Soft Computing, Alpha Science International Ltd., , 3rd edition , 2018 .
2. Dr. Nilakshi Jain, Artificial Intelligence Making a System Intelligent, wiley, 2019.

Reference Books:

1. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", 4th edition, Wiley, 2017.
2. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications", Prentice Hall, 1995.

Name of the Course	Introduction to Robotics, Sensing &Visualization		
Course Code	**MSAI-EL-313**	Credits-3	L-3, T-0, P-0
Lectures to be Delivered	45(1 Hr Each) (L=45, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Explain basic robotics concepts, including robot types, anatomy, kinematics, dynamics, and applications
CO2	Design motion planning and control algorithms for robots, including an understanding of feedback control.
CO3	Demonstrate proficiency in robot programming and analyze applications of robots in various domains.
CO4	Describe different sensing technologies used in robotics, and apply image processing techniques for robot vision.
CO5	Utilize simulation and visualization tools to represent robot environments and sensor data.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Sections A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 16% of the total marks of the semester-end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-EL-313 Introduction to Robotics, Sensing & Visualization

UNIT-I

Fundamentals of Robotics: The history and evolution of robotics, Different types of robots (industrial, mobile, service, etc.), Robot anatomy (links, joints, actuators, sensors), Kinematics - the study of robot motion without considering forces, Dynamics - the study of forces and torques that cause robot motion.

UNIT-II

Robot Motion Planning and Control: Motion planning - finding a path for a robot to reach a goal while avoiding obstacles, Control systems - designing algorithms to make robots behave in a desired way, Feedback control - using sensor data to adjust robot motion in real-time, Motion control - controlling the movement of individual robot joints.

UNIT-III

Programming and Applications: Introduction to robot programming languages, Case studies of robots in different applications (manufacturing, healthcare, agriculture, etc.)
Human-robot interaction - how humans and robots can collaborate effectively, Ethical considerations in robotics.

UNIT-IV

Sensing and Visualization: Overview of robot sensing technologies (LiDAR, ultrasonic, vision, force/tactile sensors), Sensor data acquisition and processing principles, Robot perception - fusing data from multiple sensors to create a unified understanding of the environment.

Image processing techniques for robot vision (noise reduction, filtering, feature extraction), 3D perception from cameras (depth estimation, point cloud generation) Robot simulation and visualization tools (understanding the role of visualization in interpreting sensor data) Recent advancements in sensing (tactile sensing for grasping, 3D point cloud processing), Deep learning for object recognition in robots.

Text Books:

1. Roland Siegwart, Nourbakhsh Illah R., Davide Scaramuzza, Introduction to Autonomous Mobile Robots, Publisher: MIT Press Initial Publication Year of 2nd Edition: 2011

2. Peter Corke, Robotics, Vision & Control: Fundamental Algorithms in MATLAB, Publisher: Springer Initial Publication Year of 2nd Edition: 2017.

Reference Book:

1. Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, Robotics:Modelling, Planninng and control Springer, 4th Edition, 2010.

ELECTIVE-3

Name of the Course	Text Preprocessing & Pattern Recognition		
Course Code	**MSAI-EL-321**	Credits-3	L-3, T-0, P-0
Lectures to be Delivered	45(1 Hr Each) (L=45, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Apply text preprocessing techniques to clean, normalize, and tokenize text data, including handling encodings and advanced transformations.
CO2	Represent text data using vector space models, word embeddings, and advanced feature engineering methods, addressing the challenges of large corpora.
CO3	Explain the principles of statistical pattern recognition and apply supervised and unsupervised classification and clustering techniques.
CO4	Utilize advanced pattern recognition methods including regular expressions, sequence models, topic modeling, and deep learning.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-EL-321 Text Preprocessing & Pattern Recognition

UNIT-I

Character Encodings: Unicode, UTF-8, handling various encodings, Tokenization: Word-level, sentence-level, handling contractions, abbreviations, and special characters.

Normalization: Lemmatization, stemming, case-folding, noise removal, handling misspellings, Advanced Preprocessing: Part-of-speech (POS) tagging, dependency parsing.

UNIT II

Vector Space Models: Bag-of-words, TF-IDF (term frequency-inverse document frequency), limitations, Word Embeddings: Word2Vec, GloVe, FastText, contextual embeddings (e.g., ELMo, BERT)

Feature Engineering for Text: N-grams, advanced feature selection methods, Handling Large Text Corpora: Indexing, compression, and scalability techniques.

UNIT-III

Introduction to Pattern Recognition: Principles, applications, challenges, taxonomy of pattern recognition methods, Statistical Pattern Recognition: Decision theory, Bayes' Rule, feature representation, feature selection & dimensionality reduction.

Supervised Pattern Recognition: Classification methods (k-Nearest Neighbors, Support Vector Machines, Decision Trees, Naive Bayes), Unsupervised Pattern Recognition: Clustering (k-means, Hierarchical).

UNIT-IV

Regular Expressions: Theory, syntax, practical applications in text processing, Sequence Models for Pattern Recognition: Hidden Markov Models (HMMs), Conditional Random Fields (CRFs), Recurrent Neural Networks for text.

Topic Modeling: Latent Semantic Analysis (LSA), Latent Dirichlet Allocation (LDA), Deep Learning for Pattern Recognition: Convolutional Neural Networks for text, Attention Mechanisms (e.g., Transformers).

Textbooks

1. Daniel Jurafsky and James H. Martin , "Speech and Language Processing", published by Prentice Hall, 3rd Edition November 2022.
2. Christopher M. Bishop “Pattern Recognition and Machine Learning”, Published by Springer, 2nd Edition 2022.

Reference books

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze , "Introduction to Information Retrieval", Published by Cambridge University Press, 1st Edition 2008.
2. Steven Bird, Ewan Klein, Edward Loper , "Natural Language Processing with Python", Published by O'Reilly Media, 1st Edition 2009.

Name of the Course	Evolutionary Computing		
Course Code	**MSAI-EL-322**	Credits-3	L-3, T-0, P-0
Lectures to be Delivered	45(1 Hr Each) (L=45, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 Hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Explain the principles of evolutionary computation, drawing inspiration from biological evolution
CO2	Design and implement evolutionary algorithms, choosing appropriate representations and operators.
CO3	Apply evolutionary computation to a wide range of optimization problems, including machine learning and engineering design.
CO4	Utilize advanced evolutionary computation techniques, including hybridization, multi-objective optimization, and recent research trends.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-EL-322 Evolutionary Computing

UNIT- I

Evolutionary Biology Concepts: Natural selection, fitness, populations, genes, chromosomes, mutation, crossover, selection mechanisms, Types of Evolutionary Algorithms (EAs): Genetic

algorithms (GAs), genetic programming (GP), evolutionary strategies (ES), differential evolution (DE).

Representation and Operators: Binary encoding, real-valued encoding, permutation problems, crossover techniques, mutation techniques.

UNIT - II

Fitness Functions: Definition, types of fitness landscapes, challenges of designing fitness functions, Selection Operators: Roulette wheel selection, tournament selection, ranking selection, and other methods

Constraint Handling: Penalty methods, repair methods, specialized representations and operators, Parameter Tuning: Exploration vs. exploitation, population size, mutation rate, crossover probability.

UNIT -III

Optimization Problems: Combinatorial optimization (Traveling Salesperson, Knapsack, graph coloring, etc.), Continuous optimization (function optimization, engineering design), Multi-objective optimization (handling conflicting objectives).

Machine Learning: Neuroevolution (evolving neural network architectures and weights), Feature selection and dimensionality reduction, Hyperparameter tuning of machine learning models, Finance (portfolio optimization, trading strategies), Scheduling and resource allocation, Bioinformatics (sequence alignment, protein structure prediction), Game AI (evolving game strategies).

UNIT-IV

Hybridization of EAs: Memetic algorithms (combining EAs with local search techniques), Integration with machine learning methods. Parallel and Distributed EAs: Island models, master-slave architectures, cellular EAs, Scaling EAs for large-scale problems. **Dynamic Environments:** Adapting to changing fitness landscapes, Techniques for maintaining diversity.

Multi-Objective Evolutionary Algorithms (MOEAs): Pareto dominance and Pareto fronts, MOEA techniques (NSGA-II, SPEA2, MOEA/D). Recent Developments: Co-evolutionary algorithms, Interactive evolutionary computation, Evolutionary computation for generative design.

Text Book:

1. Eiben, A.E. and Smith, J. E., Introduction to Evolutionary Computing. Springer. 2nd edition ,2015.

Reference Books:

1. David B. Fogel: "Evolutionary Computation: Toward a New Philosophy of Machine Intelligence",wiley vch,2nd edition, 2006.
2. Melanie Mitchell, "An Introduction to Genetic Algorithms",MIT Press,1998.

Name of the Course	Cognitive Systems		
Course Code	**MSAI-EL-323**	Credits-3	L-3, T-0, P-0
Lectures to be Delivered	45 (1 Hr Each) (L=45, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 Hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Explain the principles of cognitive science, analyze cognitive architectures, and understand knowledge representation techniques.
CO2	Apply computational models to simulate cognitive processes like decision-making, perception, learning, memory, and language.
CO3	Utilize the principles of embodied cognition, sensorimotor integration, and design cognitive systems for robotics.
CO4	Explore applications of cognitive systems in healthcare, analyze social phenomena, and discuss ethical considerations in the field.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-EL-323 Cognitive Systems

UNIT- I

Introduction to Cognitive Science: History of the field, core concepts, interdisciplinary nature of cognitive systems. Cognitive Architectures: ACT-R, Soar, LIDA, and others. Discuss their strengths, weaknesses, and applications.

Knowledge Representation: Semantic networks, frames, production systems, ontologies. Problem-solving and Reasoning: Search-based methods, logic-based reasoning, planning, constraint satisfaction.

UNIT-II

Decision Making: Rational models, bounded rationality, heuristics and biases, prospect theory. Perception and Attention: Visual and auditory processing, feature-based vs. object-based attention, models of attentional control, multisensory perception.

Learning and Memory: Types of memory (episodic, semantic, procedural), reinforcement learning, Hebbian learning, neural network models of memory.

Language: Natural language processing, language understanding and generation, grammar and parsing models.

UNIT-III

Embodiment: Grounded cognition, role of the body and environment in shaping cognitive processes. Sensorimotor Integration: Perception-action loop, sensor fusion, control systems for embodied agents.

Cognitive Robotics: Architectures for cognitive robots, planning and decision making in dynamic environments. Human-Robot Interaction: Social cognition in robots, collaboration, communication modalities.

UNIT -IV

Cognitive Neuroscience: Neuroimaging methods (fMRI, EEG), mapping cognitive functions to brain regions. Cognitive Systems in Healthcare: Diagnosis, decision support, cognitive rehabilitation, brain-computer interfaces.

Cognitive Modeling of Social Phenomena: Social networks, opinion dynamics, collective decision making. Ethical Considerations: Fairness, transparency, accountability, and potential biases in cognitive systems.

Text Books:

1. Jerome Busemeyer and Peter Bruza ,Quantum Models of Cognition and Decision, Cambridge University Press ,2012
2. "Stuart Russell and Peter Norvig , Artificial Intelligence: A Modern Approach", pearson 4th edition,2020.

Reference Books:

1. Margaret A Boden."Mind as Machine: A History of Cognitive Science volume 1" , clarendon press, 2006 .
2. Lawrence Shapiro,"Embodied Cognition" , Routledge,2nd edition,2019.

SEMESTER-IV

Name of the Course	**PROJECT WORK**		
Course Code	**MSAI-401**	Credits-18	Internship/Project
Project/Internship outside HPU			
Semester End Examination	External Marks: 250		Min. Pass Marks:100
Internal Assessment (based on Internship/Project Report 50%, Seminar 25% and 25% Log Book & Interim Report)		Max. Marks:200	Min. Pass Marks:80
OR			
Project/Internship inside HPU			
Semester End Examination	External Marks: 150		Min. Pass Marks:60
End Semester Examination Elective-4	External Marks: 75		Min. Pass Marks:30
End Semester Examination Elective-4	Internal Assessment: 25		Min. Pass Marks:10
Internal Assessment (based on Project/Internship Report 50%, Seminar 25% and 25% Log Book & Interim Report)		Max. Marks:200	Min. Pass Marks:80

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Utilize the methods and techniques of system development.
CO2	Apply best practices for effective project management.
CO3	Analyze the real life problems in order to develop optimum solutions.
CO4	Evaluation of project deliverables.
CO5	Creation of team spirit and profession ethics.

The fourth semester of MSc Artificial Intelligence primarily focuses on practical experience and applied knowledge through project work, internships, and electives. Students will engage in independent projects, and the evaluation will be based on several components, including seminars, reports, and viva-voce exams.

In the Third semester, the Chairman/Head of the Department will assign a guide/supervisor to each candidate for his/her Project Work. The candidate shall be required to maintain his/her Project diary (logbook) of work in the Organization / Department. Each student will be required to give at least two seminars on his/her project work (one in the mid semester and other in the end of the semester), dates to be decided by the department. Each student is required to submit three copies

of his/her project reports in the Department after completion of the project work which will be evaluated by an external examiner.

Further, the Project work (final semester) will be jointly evaluated by an internal guide and external examiner. Internal assessment will be given on Internship/Project Report, Seminar and Log Book & Interim Report, be evaluated by the department.

1. **Project/Internship Work outside HPU:**

    - Students are required to undertake a significant project during this semester.
    - **Seminar:** Students will present their project progress through two seminars, which will account for 50 marks.
    - **Log Book & Interim Report:** Regular tracking of project work will be assessed through logbooks and interim reports, worth another 50 marks.
    - **Project/Internship Report:** After completing their project, students will submit a project/internship report, accounting for 100 marks.
    - **Viva-Voce**: After completing their project, students will participate in a viva-voce, accounting for 250 marks.

2. **Elective Path :**
    - Alternatively, students can choose to work on an elective (Elective 4) instead of a project/ internship outside HPU. The elective carries 100 marks.
    - **Seminar:** Students will present their project progress through two seminars, which will account for 50 marks.
    - **Log Book & Interim Report:** Regular tracking of project work will be assessed through logbooks and interim reports, worth another 50 marks.
    - In this pathway, students will still need to submit a project/internship report, which will account for 100 marks.
    - **Viva-Voce**: After completing their project, students will participate in a viva-voce, accounting for 150 marks.
    - and complete a viva-voce for 250 marks.

Total Marks Distribution:

- The entire semester is evaluated out of 450 marks.
    - For students undertaking project work and internship: **250** marks (EE) + 2**00** marks (IA) = **450** total marks.
    - For students opting for the elective path: **225** marks (EE) + **225** marks (IA) = **450** total marks.

ELECTIVE-4

Name of the Course	Virtual Reality and Augmented Reality		
Course Code	**MSAI-EL-411**	Credits-4	L-4, T-0, P-0
Lectures to be Delivered	60 (1 Hr Each) (L=60, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 Hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Explain the applications of VR and AR in various domains, including industry, healthcare, sustainability, and societal impact.
CO2	Utilize the technological landscape of VR/AR, including hardware, software, and its democratization.
CO3	Explore the potential of VR/AR for entertainment, brain-computer interfaces, and alternative perception experiences.
CO4	Analyze the challenges of AR and VR, including technical limitations, presence issues, and health risks associated with their widespread use.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-EL-411 Virtual Reality and Augmented Reality

UNIT - I

Introduction & New Applications: New Industrial applications- Virtual reality in industry, Augmented reality and industrial applications, VR-AR for industrial renewal, And about augmented reality; Computer – Assisted Surgery- Introduction, Virtual reality and simulation for learning, Augmented reality and intervention planning, Augmented reality in surgery, Current conditions and future prospects; Sustainable cities- Mobility aids in an urban environment, Building and architecture, Cities and urbanism, Towards sustainable urban systems; Innovative, integrative and adaptive societies- Education, Arts and cultural heritage.

UNIT- II

The Democratization of VR-AR: New equipment- Introduction, Positioning and Orientation devices, Restitution devices, Technological challenges and perspectives; New Software- Introduction, Developing 3D Applications, Managing peripheral devices, Dedicated VR_AR Software solutions.

UNIT- III

Scientific and Technical Prospects: The promised revolution in the field of entertainment- Introduction, Defining a new, polymorphic immersive medium, Promised experiences, Prospects; Brain-computer interfaces- Brain-computer interfaces: introduction and definition, Working principle of BCIs, Current applications of BCIs, The future of BCIs; Alternative perceptions in virtual reality- Introduction, Pseudo-sensory feedback, Alternative perception of movement, Altered perception of one's body.

UNIT- IV

Towards VE that are More Closely Related to the Real World: "Tough" scientific challenges for AR, Topics in AR that are rarely or never approached, Spatial augmented reality, Presence in augmented reality, 3D interaction on tactile surfaces.

The Challenges and Risks of Democratization of VR-AR: Introduction, Health and comfort problems, Solutions to avoid discomfort and unease.

Text Book:

1. Bruno Arnaldi, Pascal Guitton, Guillaume Moreau, Virtual Reality and Augumented Reality: Myths and Reality, John Wiley & Sons, Inc., 2018.

Reference Books:

1. Alan B Craig, William R Sherman, Jeffrey D Will, Developing Virtual Reality Applications: Foundations of Effective Design, Morgan Kaufmann, 2009.
2. Gerard Jounghyun Kim, Designing Virtual Systems: The Structured Approach, 2005.
3. Doug A Bowman, Ernest Kuij, Joseph J La Viola, Jr and Ivan Poupyrev, 3D User Interfaces, Theory and Practice, Addison Wesley, USA, 2005.
4. Oliver Bimber, Ramesh Raskar, Spatial Augmented Reality: Meging Real and Virtual Worlds, 2005.
5. Burdea, Grigore C, Philippe Coiffet, Virtual Reality Technology, Wiley Interscience, India, 2003.

Name of the Course	**Introduction to Blockchain**		
Course Code	**MSAI-EL-412**	Credits-4	L-4, T-0, P-0
Lectures to be Delivered	60(1 Hr Each) (L=60, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 Hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Explain core blockchain concepts and the mechanisms behind Bitcoin and Ethereum.
CO2	Utilize the potential of blockchain for decentralized data marketplaces, identity solutions, and AI collaboration.
CO3	Analyze challenges and limitations of using blockchain for data science tasks.
CO4	Explore enterprise blockchain applications and emerging use cases relevant to data science and AI.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-EL-412 **Introduction to Blockchain**

UNIT- I

Distributed Ledger Technology (DLT): Principles, properties (decentralization, immutability, transparency), key distinctions from centralized databases. Consensus Mechanisms: Proof-of-Work (PoW), Proof-of-Stake (PoS), Byzantine Fault Tolerance (BFT), and their tradeoffs in scalability, security, and energy use.

Cryptography Fundamentals: Hash functions (SHA-256 etc.), public/private key cryptography, digital signatures, and their role in blockchain security.

UNIT- II

Bitcoin Protocol: Mining, transactions, block structure, the Merkle tree, UTXO model, difficulty adjustments, limitations. Ethereum and Smart Contracts: Ethereum Virtual Machine (EVM) Solidity language, accounts vs. contracts, gas, and decentralized applications (DApps). Alternative Cryptocurrencies and Public Blockchains: Exploring different coins (altcoins), stablecoins, forks, innovations in consensus, and sidechains.

UNIT- III

Decentralized Data Marketplaces: Explore platforms for data exchange and monetization, implications for data privacy and ownership. Identity and Reputation Systems: Self-sovereign identity, zero-knowledge proofs, and their use in building trust within distributed communities.

AI on the Blockchain: Smart contract-governed AI models, decentralized AI marketplaces, federated learning on the blockchain. Challenges of Blockchain for Data Science: Limitations in scalability, computation on-chain, reconciling immutability with data science practices.

UNIT-IV

Permissioned Blockchains: Hyperledger Fabric, Corda, their architecture, governance, and suitability for enterprise use cases. Supply Chain Management: Provenance tracking, trade finance, combating counterfeit goods.

Financial Applications: Cross-border payments, tokenization of assets, enabling new forms of securities. Emerging Use Cases: NFTs (Non-Fungible Tokens), Internet of Things (IoT), and decentralized governance.

Text Book:

1. Andreas M. Antonopoulos,"Mastering Bitcoin: Unlocking Digital Cryptocurrencies" , O'rilley media, 1st edition, 2014.

Name of the Course	Multi Agent Systems		
Course Code	**MSAI-EL-413**	Credits-4	L-4, T-0, P-0
Lectures to be Delivered	60 (1 Hr Each) (L=60, T=0 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 Hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25** **Min Marks: 10**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	Define intelligent agents, their characteristics, and interactions within multi-agent environments.
CO2	Apply decision-making, utility theory, and game theory concepts to model multi-agent scenarios.
CO3	Design algorithms for multi-agent coordination, task allocation, and resource distribution.
CO4	Utilize logical formalisms to reason about knowledge, belief, and intentions within multi-agent systems.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 9 subparts of short answer type, which will cover the entire syllabus, ensuring only 2-3 questions total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 12 marks out of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

MSAI-EL-413 Multi Agent Systems

UNIT -I

Intelligent Agents and their Environment: Definition and characteristics of intelligent agents, Types of agents (reflex, model-based, goal-based, utility-based),Environment types (accessible, deterministic, episodic, static, discrete, single-agent),Reactive, proactive, and social behaviour of agents.

Rational Decision Making: Utility theory and preferences, Decision theory (decision networks, influence diagrams),Maximum expected utility principle, Von Neumann-Morgenstern utility theorem, Decision-making algorithms (value iteration, policy iteration, reinforcement learning)

Game Theory and Multi-Agent Environments: Normal-form games and solution concepts (Nash equilibrium, dominant strategies),Extensive-form games and solution concepts (subgame perfection, backward induction),Mixed strategies, Repeated games.

UNIT -II

Centralized Mechanisms and Algorithms: Task allocation problems and algorithms, Coalition formation algorithms, Resource allocation algorithms.

Distributed Mechanisms and Algorithms: Distributed constraint optimization (DPOP, ADOPT),Distributed planning algorithms, Distributed task allocation algorithms.

Communication and Coordination: Communication protocols (contract nets, negotiation),Coordination strategies (organizational structures, norms).Auctions and Mechanism Design, Auction types (English, Dutch, Vickrey),Mechanism design principles (incentive compatibility, individual rationality),Applications of auctions and mechanisms.

UNIT- III

Game Theory Basics: Strategic games (normal and extensive form),Solution concepts (Nash, ,subgame perfection, trembling hand perfection),Bayesian games and incomplete information. Repeated Games and Equilibrium Concepts, Infinitely repeated games, Equilibrium concepts (Nash folk theorems, subgame perfect epsilon-equilibrium),Reputation formation.

Coalitional Game Theory: Transferable utility games, Solution concepts (core, Shapley value, nucleolus),Coalition formation algorithms. Mechanism Design and Social Choice: Mechanism design basics (revelation principle, Vickrey-Clarke-Groves mechanisms),Social choice theory (voting rules, Arrow's impossibility theorem),Cost sharing mechanisms

UNIT- IV

Knowledge Representation and Reasoning: Propositional and first-order logic, Description logics, Reasoning techniques (resolution, tableaux, model checking).Modal Logics of Knowledge and Belief: Possible worlds semantics, Modal logics of knowledge and belief (S5, KD45),Modeling multi-agent epistemic states.

Multi-Agent Logics and Reasoning: Logics of action and ability, Logics of strategic ability, Logics of preference and intention. Temporal and Dynamic Logics: Linear and branching time logics, Dynamic epistemic logics, Model checking multi-agent systems.

Text Books:

1. Shoham, Yoav, and Kevin Leyton-Brown. Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations. 2nd ed., Cambridge University Press, 2021.

2. Wooldridge, Michael. An Introduction to MultiAgent Systems. 2nd ed., John Wiley & Sons, 2009.
3. Weiss, Gerhard, ed. Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence. 2nd ed., The MIT Press, 2013.

Reference Books:

1. Rahwan, Iyad, and Graham R. Simari, eds. Negotiation and Argumentation in Multi-Agent Systems. 1st ed., Springer, 2009.
2. Rosenschein, Jeff, and Michael Wooldridge. Principles of Multiagent Systems. 1st ed., Cambridge University Press, 2022.

DEPARTMENT OF DATA SCIENCE AND ARTIFICIAL INTELLIGENCE

HIMACHAL PRADESH UNIVERSITY SHIMLA

Syllabus for the Entrance Exam of M.Sc. Data Science and M.Sc. Artificial Intelligence

Sr. No	Contents	Marks
1.	ICT Awareness	60
2.	Mathematics	20
3.	General Logic Ability & Aptitude	20
Total		**100**

The minimum qualifying marks in the Entrance Examination (written test) for subsidized as well as non-subsidized seats will be as per university norms.

Detailed Syllabus

1. ICT Awareness

10 questions worth 1 mark each *will have to be set from each of the following six sections, for a total of* ***60 questions****.*

1. **Fundamentals of Computers**: Introduction to computers, types of computers, components of a computer system (hardware and software), basics of computer architecture, input and output devices, memory hierarchy and types of memory, types of software (system software, application software), binary and other number systems, evolution of computing generations, boot operation and fundamentals of digital logic (AND, OR, NOT gates).
2. **Operating System**: Functions of operating systems, types of operating systems (batch, time-sharing, distributed, real-time), basics of process management (process creation, scheduling algorithms, inter-process communication), memory management techniques (paging and segmentation), file systems and file management, basics of scheduling algorithms, deadlock prevention and handling, types of user interfaces (CLI, GUI), Linux and Windows operating system basics.
3. **Computer Networking and Data Communication**: Basics of computer networks, types of networks (LAN, MAN, WAN), network topologies, OSI and TCP/IP models, data encapsulation and packet switching, protocols (IP, TCP, UDP, HTTP, FTP, SMTP), types of transmission media (coaxial, fiber optic, wireless), network devices (router, switch, hub), error detection and correction techniques, data link and network layer functionalities, network security concepts (encryption, firewalls, VPNs), IPv4 and IPv6 addressing.
4. **Database Management System (DBMS)**: Basics of databases, types of databases (relational, NoSQL, hierarchical, object-oriented), entity-relationship (ER) modeling, relational database design, normalization (1NF, 2NF, 3NF, BCNF), SQL basics (queries, subqueries, joins, aggregation), database indexing, basics of transactions and concurrency control, ACID properties, introduction to stored procedures and triggers.

5. **Data Structures**: Types of data structures (arrays, linked lists, stacks, queues, trees, graphs), algorithm complexity (Big O), searching and sorting algorithms (linear search, binary search, bubble sort, selection sort, merge sort, quicksort), operations on data structures (insertion, deletion, traversal), basics of recursion ,hashing and hash tables, binary trees, binary search trees.
6. **Software Engineering**: Introduction to software development lifecycle (SDLC), software development models (waterfall, agile, V-model), requirement analysis and specifications, software design concepts (modularity, cohesion, coupling, data flow diagrams), object-oriented analysis and design (OOAD), software testing methods (unit testing, integration testing, system testing, acceptance testing), maintenance and evolution, software project management basics (cost estimation, scheduling, risk analysis), introduction to software quality assurance, software metrics.

2. Mathematics

2 questions worth 1 mark each *will have to be set from each of the following 10 sections, for a total of* ***20 questions***

1. **Number System**: Types of numbers (natural, whole, integers, rational, irrational, prime), divisibility rules, factors and multiples, HCF and LCM, and basic operations.
2. **Fractions and Decimals**: Conversions between fractions and decimals, basic operations, and comparisons.
3. **Percentages**: Concepts of percentages, percentage change, increase and decrease, and applications in problem-solving.
4. **Ratios and Proportion**: Understanding ratio, proportion, direct and inverse variation, and their applications.
5. **Averages**: Calculation of averages, weighted averages, and applications in real-life scenarios.
6. **Simple and Compound Interest**: Basics of interest calculations, differences between simple and compound interest, and applications in finance problems.
7. **Profit, Loss, and Discounts**: Calculating profit and loss, percentage profit/loss, marked price, cost price, and discounts.
8. **Time and Work**: Basics of work and time, problems on work efficiency, combined work, and problems involving pipes and cisterns.
9. **Time, Speed, and Distance**: Concepts of speed, distance, and time, relative speed, and problems on trains, boats, and streams.
10. **Differentiation and Integration**: Basics of differentiation (simple rules, chain rule, product rule), basic integration (antiderivatives), applications in finding tangents, areas under curves, and solving problems related to rates of change.

3. General Logic Ability and Aptitude

2 questions worth 1 mark each *will have to be set from each of the following 10 sections, for a total of* ***20 questions****.*

1. **Analogy**: Identifying relationships between words, numbers, or shapes and selecting the correct analogy.
2. **Classification**: Grouping similar items or figures based on certain characteristics, and identifying the odd one out.
3. **Series Completion**: Finding the next number, letter, or shape in a given series based on a pattern.
4. **Coding-Decoding**: Understanding and interpreting codes, where letters or numbers are substituted for other letters or numbers, and solving related puzzles.
5. **Blood Relations**: Solving problems based on familial relationships, determining relationships between different family members.
6. **Direction Sense**: Problems involving directions (north, south, east, west), distance, and the relative positions of objects or people.
7. **Syllogism**: Understanding statements and conclusions, and solving problems based on logical deductions using Venn diagrams.
8. **Puzzle Test**: Solving problems involving arrangement or sequencing based on given conditions (e.g., seating arrangement, order of events).
9. **Logical Venn Diagrams**: Solving problems based on the relationships between different sets of objects, with the help of Venn diagrams.
10. **Statement and Assumptions**: Interpreting and solving problems involving given statements and assumptions, determining whether the assumption follows from the statement.

SAMPLE QUESTION PAPER

Below is a **sample question paper** with **2 multiple-choice questions from each section** Each question includes **four answer options**.

1. ICT Awareness

Fundamentals of Computers

- Which of the following is an input device?
  A. Printer
  B. Monitor
  C. Keyboard
  D. Speaker
- The primary memory of a computer is:
  A. Hard Disk
  B. RAM
  C. CD-ROM
  D. USB Drive

Operating System

- Which of the following is *not* a function of an operating system?
  A. Managing memory
  B. Creating web pages
  C. Handling files
  D. Process management
- Linux is an example of a:
  A. System software
  B. Application software
  C. Utility software
  D. Firmware

Computer Networking and Data Communication

- Which of the following is a network device used to connect different networks?
  A. Switch
  B. Hub
  C. Router
  D. Modem
- In the OSI model, the function of data encryption is performed at the:
  A. Physical layer
  B. Network layer
  C. Transport layer
  D. Presentation layer

Database Management System (DBMS)

- Which of these is a property of a relational database?
  A. Uses object inheritance
  B. Organized in tables
  C. Uses HTML tags
  D. Stores data in a flat file
- The command used to retrieve data from a database is:
  A. UPDATE
  B. SELECT
  C. DELETE
  D. INSERT

Data Structures

- A linear data structure where elements are inserted at one end and removed from the other is called:
  A. Stack
  B. Array
  C. Queue
  D. Graph
- The time complexity of binary search in a sorted array is:
  A. O(n)

B. O(log n)
C. $O(n^2)$
D. O(1)

Software Engineering

- In which software model is each phase completed before the next one begins?
  A. Agile
  B. Waterfall
  C. Spiral
  D. V-Model
- What does SDLC stand for?
  A. Software Data Learning Cycle
  B. Structured Design Logic Code
  C. Software Development Life Cycle
  D. System Debugging Lifecycle

2. Mathematics

Number System

- Which of the following is a prime number?
  A. 21
  B. 17
  C. 33
  D. 27
- HCF of 18 and 24 is:
  A. 2
  B. 3
  C. 6
  D. 12

Fractions and Decimals

- 0.25 is equal to:
  A. 1/2
  B. 1/4
  C. 3/4
  D. 1/8
- 2/5 + 3/10 equals:
  A. 5/10
  B. 4/5
  C. 7/10
  D. 1

Percentages

- 25% of 160 is:
  A. 40
  B. 60

C. 20
D. 80

- A number increases from 80 to 100. The percentage increase is:
  A. 20%
  B. 25%
  C. 18%
  D. 22%

Ratios and Proportion

- If A : B = 2 : 3, and B : C = 4 : 5, then A : C is:
  A. 8 : 15
  B. 2 : 5
  C. 3 : 10
  D. 4 : 9
- If 5 pens cost Rs. 60, then 8 pens will cost:
  A. Rs. 90
  B. Rs. 96
  C. Rs. 100
  D. Rs. 120

Averages

- The average of 4, 6, and 10 is:
  A. 6
  B. 7
  C. 8
  D. 9
- The average of five numbers is 20. The sum is:
  A. 80
  B. 100
  C. 120
  D. 140

Simple and Compound Interest

- Simple interest on Rs. 1000 at 5% for 2 years is:
  A. Rs. 50
  B. Rs. 100
  C. Rs. 200
  D. Rs. 75
- The compound interest on Rs. 1000 at 10% per annum for 2 years is:
  A. Rs. 200
  B. Rs. 210
  C. Rs. 220
  D. Rs. 100

Profit, Loss, and Discounts

- A person bought an item for Rs. 200 and sold it for Rs. 250. The profit percentage is:
  A. 20%
  B. 25%
  C. 30%
  D. 50%
- If the marked price is Rs. 500 and the discount is 10%, selling price is:
  A. Rs. 450
  B. Rs. 400
  C. Rs. 480
  D. Rs. 470

Time and Work

- If A can do a job in 6 days and B in 12 days, together they can finish it in:
  A. 2 days
  B. 3 days
  C. 4 days
  D. 5 days
- Two taps can fill a tank in 12 and 15 minutes. Together, they take:
  A. 6.5 min
  B. 6 min
  C. 7 min
  D. 7.5 min

Time, Speed, and Distance

- A car travels 60 km in 1.5 hours. Its speed is:
  A. 40 km/h
  B. 50 km/h
  C. 60 km/h
  D. 80 km/h
- A train 100 meters long crosses a pole in 10 seconds. Its speed is:
  A. 10 m/s
  B. 20 m/s
  C. 100 m/s
  D. 15 m/s

Differentiation and Integration

- Derivative of x^2 is:
  A. x
  B. 2x
  C. x^3
  D. $3x^2$

- Integral of 2x dx is:
  A. $x^2 + C$
  B. $x^3 + C$
  C. $2x^2 + C$
  D. x^2

3. General Logic Ability and Aptitude

Analogy

- Book : Reading :: Fork : ?
  A. Drawing
  B. Writing
  C. Stirring
  D. Eating
- Moon : Satellite :: Earth : ?
  A. Star
  B. Planet
  C. Galaxy
  D. Orbit

Classification

- Which one is different from the rest?
  A. Apple
  B. Banana
  C. Carrot
  D. Mango
- Find the odd number:
  A. 2
  B. 3
  C. 5
  D. 9

Series Completion

- 2, 4, 8, 16, ?
  A. 18
  B. 24
  C. 32
  D. 30
- A, C, E, G, ?
  A. H
  B. I
  C. J
  D. K

Coding-Decoding

- If CAT = 24, then DOG = ?
  A. 26
  B. 30
  C. 28
  D. 22
- In a certain code, FLOW is written as GMPX. How is RAIN written?
  A. SBLM
  B. SBJO
  C. QZHM
  D. RAKO

Blood Relations

- If A is B's mother and B is C's father, what is A to C?
  A. Aunt
  B. Sister
  C. Grandmother
  D. Cousin
- If X is the brother of Y and Y is the sister of Z, then how is X related to Z?
  A. Cousin
  B. Brother
  C. Uncle
  D. Cannot be determined

Direction Sense

- A man walks north, then turns right, then right again. In which direction is he now?
  A. South
  B. East
  C. West
  D. North
- If east becomes north, what does north become?
  A. West
  B. East
  C. South
  D. South-East

Syllogism

- All pens are blue. Some blue things are round. Conclusion: Some pens are round. Is it:
  A. True
  B. False
  C. Can't say
  D. Both A and B
- No cats are dogs. All dogs are animals. So, some animals are not cats. Is this:
  A. True
  B. False

C. Can't say
D. None

Puzzle Test

- Four friends sit in a row. A is left to B but right to C. Who is in the middle?
  A. A
  B. B
  C. C
  D. Can't be determined
- If Monday is the first day of the month, what day will the 15th be?
  A. Tuesday
  B. Wednesday
  C. Monday
  D. Sunday

Logical Venn Diagrams

- Which group best represents: Men, Fathers, Engineers?
  A. All are separate
  B. Men ⊃ Fathers ⊃ Engineers
  C. Engineers ⊂ Fathers ⊂ Men
  D. Engineers ⊃ Men ⊃ Fathers
- Choose the best Venn diagram: Doctors, Males, Humans.
  A. All overlapping circles
  B. Non-overlapping
  C. One inside another
  D. Two inside one

Statement and Assumptions

- Statement: "Use eco-friendly bags." Assumption:
  A. Plastic bags are harmful
  B. All people use plastic
  C. Bags are free
  D. Eco-friendly bags are expensive
- Statement: "Join the evening yoga class." Assumption:
  A. People are free in the evening
  B. Everyone loves yoga
  C. Yoga is for old people
  D. The class is free