Curriculum for Undergraduate Degree (B.Tech.) in Artificial Intelligence and Machine Intelligence (w.e.f. AY: 2021-22)

Part III: Detailed Curriculum

Fourth Semester

Course Name:	**Discrete Mathematics**		
Course Code:	ES-IT401	**Category:**	Engineering Science Course
Semester:	Fourth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Some concepts from basic math – algebra, geometry, pre-calculus
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To use mathematical logics and Boolean algebra in the field of computer applications.
2	To know about Set-Relation-Function and Group theory.
3	To learn counting techniques and number theory.
4	To use the concept of graph theory in engineering problems.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Sets-Relation-Function:** ➢ Operations and Laws of Sets ➢ Cartesian Products, Binary Relation, Equivalence Relation, Partial Ordering Relation, Lattice **Number Theory** ➢ Proofs by Mathematical Induction ➢ The Division Algorithm, Prime Numbers, The Greatest Common Divisor, Euclidean Algorithm, The Fundamental Theorem of Arithmetic	10L
2	**Combinatorics:** ➢ Basic Counting Techniques, Inclusion and Exclusion Theorem ➢ Permutation and Combination ➢ Pigeon-Hole Principle	6L

3	**Propositional Logic and Proofs:** ➢ Basic Connectives and Truth Tables of propositional logics, Disjunctive and Conjunctive Normal Form using truth table, Argument ➢ Quantifiers and their uses ➢ Proofs; Forward Proof, Proof by Contradiction, Proof by Contraposition, Proof by Mathematical Induction ➢ The Laws of Logic, Logical Implication, Rules of Inference	8L
4	**Algebraic Structures and Boolean Algebra:** ❖ **Algebraic Structures with one Binary Operator** ➢ Group, Subgroup, Cyclic group, Permutation group, Symmetric group. ➢ Coset, Lagrange's Theorem, Normal Subgroup, Quotient group ➢ Homomorphism and Isomorphism of groups ❖ **Algebraic Structures with two Binary Operators** ➢ Rings, Integral Domain and Fields ❖ **Boolean Algebra** ➢ Identities of Boolean Algebra, Duality, Representation of Boolean Function, Disjunctive and Conjunctive Normal Form ➢ Switching network from Boolean expression using Logic Gates ➢ Karnaugh Map	10L
5	**Advanced Graph Theory:** ➢ Planar and Dual graph: Kuratowski's graphs, Euler's formulae for connected and disconnected planar graphs, Detection of planarity ➢ Graph Coloring: Vertex coloring, Chromatic number of complete graph, circuit and bipartite graph, Chromatic polynomial ➢ Connectivity and matching	6L
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Express a logic sentence in terms of predicates, quantifiers, and logical connectives
2	Derive the solution for a given problem using deductive logic and prove the solution based on logical inference
3	Classify its algebraic structure for a given a mathematical problem,
4	Evaluate Boolean functions and simplify expressions using the properties of Boolean

	algebra
5	Develop the given problem as graph networks and solve with techniques of graph theory

Learning Resources:	
1	Russell Merris, Combinatorics, Wiley-Interscience series in Discrete Mathematics and Optimisation.
2	N. Chandrasekaran and M. Umaparvathi, Discrete Mathematics, PHI
3	Gary Haggard, John Schlipf and Sue Whitesides, Discrete Mathematics for Computer Science, CENGAGE Learning
4	Gary Chartrand and Ping Zhang – Introduction to Graph Theory, TMH
5	J.K. Sharma, Discrete Mathematics, Macmillan
6	Winfried Karl Grassmann and Jean-Paul Tremblay, Logic and Discrete Mathematics, PRSEAON.
7	S. K. Chakraborty and B. K. Sarkar, Discrete Mathematics, OXFORD University Press.
8	Douglas B. West, Introduction to graph Theory, PHI
9	C. L. Liu, Elements of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 2000.
10	R. C. Penner, Discrete Mathematics: Proof Techniques and Mathematical Structures, World Scientific, 1999.
11	R. L. Graham, D. E. Knuth, and O. Patashnik, Concrete Mathematics, 2nd Ed., Addison-Wesley, 1994.
12	N. Deo, Graph Theory, Prentice Hall of India, 1974.
13	S. Lipschutz and M. L. Lipson, Schaum's Outline of Theory and Problems of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 1999.
14	J. P. Tremblay and R. P. Manohar, Discrete Mathematics with Applications to Computer Science, Tata McGraw-Hill, 1997.
15	Higher Algebra- S.K. Mapa
16	N. Chandrasekaran and M. Umaparvathi, Discrete Mathematics, PHI
17	S.B. Singh, Discrete Structures – Khanna Publishing House (AICTE Recommended Textbook – 2018)
18	S.B. Singh, Combinatorics and Graph Theory, Khanna Publishing House (AICTE Recommended Textbook – 2018)

Course Name:	**Design and Analysis of Algorithms**		
Course Code:	PC-IT402	**Category:**	Professional Core Courses
Semester:	Fourth	**Credit:**	3
L-T-P:	3-1-0	**Pre-Requisites:**	Concept of Data Structure & Algorithm
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To analyze the asymptotic performance of algorithms.
2	To be familiar with major algorithms and data structures.
3	To apply important algorithmic design paradigms and methods of analysis.
4	To Synthesize efficient algorithms in common engineering design situations.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Characteristics of algorithm; Analysis of algorithm: Asymptotic analysis of complexity bounds – best, average and worst-case behavior; Performance measurements of Algorithm, Time and space trade-offs; Analysis of recursive algorithms through recurrence relations: Iterative method, Substitution method, Recursion tree method and Masters' theorem.	8L
2	**Fundamental Algorithmic Strategies:** Divide and Conquer, Greedy, Dynamic Programming, Branch and Bound and Backtracking methodologies for the design of algorithms; Illustrations of these techniques for Problem.	10L
3	**Graph and Tree Algorithms:** Traversal algorithms: Depth First Search (DFS) and Breadth First Search (BFS); Shortest path algorithms, Transitive closure, Minimum Spanning Tree, Topological sorting, Network Flow Algorithm.	10L
4	**Tractable and Intractable Problems:** Computability of Algorithms, Computability classes – P, NP, NP-complete and NP-hard. Cook6's theorem, Standard NP-complete problems and Reduction techniques.	8L
5	**Advanced Topics:** Approximation algorithms, Randomized algorithms, Class of problems beyond NP – P SPACE	4L
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Analyze given algorithm for worst-case running times based on asymptotic analysis and justify the correctness of algorithms.
2	Describe the different categories of algorithm and explain when an algorithmic design needs call for an appropriate category, also to synthesize and analyze it in terms of computational complexity
3	Model a given engineering problem using graph and write the corresponding algorithm

	to solve the problems.
4	Explain the ways to analyze randomized algorithms (expected running time, probability of error).
5	Explain what an approximation algorithm is and to compute the approximation factor of an approximation algorithm

Learning Resources:	
1	"Algorithm Design", 1ST Edition, Jon Kleinberg and Éva Tardos, Pearson.
2	"Algorithm Design: Foundations, Analysis, and Internet Examples", Second Edition, Michael T Goodrich and Roberto Tamassia, Wiley.
3	"Algorithms - A Creative Approach", 3RD Edition, Udi Manber, Addison-Wesley, Reading, MA
4	"Fundamentals Of Computer Algorithms" by Horowitz, Sahani, Universities Press

Course Name:	**Artificial Intelligence**		
Course Code:	PC-AIML401	**Category:**	Professional Elective Courses
Semester:	Fourth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Data Structure, Concept of Probability
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To learn the basics concepts of Artificial Intelligent System
2	To know the special data structure for the domain
3	To understand reasoning process
4	To know how the system learns
5	To have idea about Expert System

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Overview of Artificial intelligence- Problems of AI, AI technique, Water Jug problem.	4L
2	**Intelligent Agents :** Agents & environment, nature of environment, structure of agents, goal based agents, utility based agents, learning agents	3L

3	**Search techniques:** Solving problems by search, depth first search, depth limited search, bidirectional search, comparing uniform search strategies. **Heuristic search strategies :** Hill climbing search, Best-first search, A* search, **Adversarial search** : Games, optimal decisions & strategies in games, the minimax search procedure, alpha-beta pruning, **Memory bounded heuristic search**: simulated annealing search, local beam search, genetic algorithms; constraint satisfaction problems, local search for constraint satisfaction problems.	8L
4	**Using predicate logic**: Representing simple fact in logic, representing instant & ISA relationship, computable functions & predicates, resolution, natural deduction.	6L
5	**Probabilistic reasoning**: Representing knowledge in an uncertain domain, the semantics of Bayesian networks, Dempster-Shafer theory, Fuzzy sets & fuzzy logics.	6L
6	**Learning** : Forms of learning, inductive learning, learning decision trees, explanation based learning, learning using relevance information, neural net learning	6L
7	**Planning:** Role of planning in AI, planning vs problem solving, planning as a logical inference problem, planning vs deduction: Situation Calculus, need of special purpose algorithm, STRIPS language, plan by searching for a satisfactory sequence of actions, representation of plans. Case study: Plan for Shoes and Sock problem	4L
8	**Expert System**: expert system shells, knowledge acquisition.	3L
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand how an intelligent agent works
2	Learn specific data structure for this field
3	Understand the application of logic and concept of probability in reasoning
4	Understand the importance of learning
5	Have idea about Expert System

Learning Resources:	
1	"Artificial Intelligence", Ritch & Knight, TMH
2	"Artificial Intelligence A Modern Approach", Stuart Russel Peter Norvig Pearson
3	"Introduction to Artificial Intelligence & Expert Systems", Patterson, PHI
4	"Logic & Prolog Programming", Saroj Kaushik, New Age International
5	"Expert Systems", Giarranto, VIKAS

Course Name:	**Machine Learning Foundations**		
Course Code:	PC-AIML402	**Category:**	PE
Semester:	Fourth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic knowledge of probability and statistics and knowledge of programming
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To learn the concept of how to learn patterns and concepts from data without being explicitly programmed
2	To design and analyze various machine learning algorithms and techniques
3	Explore supervised and unsupervised learning paradigms of machine learning
4	To explore recent trends in various machine learning techniques

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction to Machine Learning:** • Probability Basics • Machine Learning Concepts • Application, Issues and tools of Machine Learning	4L
2	**Concept Learning:** Inductive learning hypothesis, FIND-S algorithm, Version space, candidate elimination algorithm, Inductive bias	4L
3	**Bayesian Learning:** Naive Bayes Classifier, Optimal Classifier	3L
4	**Supervised Learning (Regression/Classification)**: • Basic Classification methods: k-Nearest-Neighbors, Decision Trees, Support Vector Machine • Regression: Simple and Multiple Regression, Logistic Regression	9L
5	**Unsupervised Learning:** • Clustering Techniques: Partitioning methods (k-Means, k-Medoid). Hierarchical methods(Agglomerative and Decisive Techniques: MIN, MAX, Group Average, Ward's method) and Density based Methods (DBSCAN) • Soft clustering Algorithms: Weighted K-means, FCM	7L
6	**Model Evaluation:** • Evaluating Machine Learning algorithms and Model Selection	4L

	• Ensemble Methods (Boosting, Bagging, Random Forests)	
7	**Artificial Neural Network:** • How ANN Works, Activation functions, Perceptron, McCulloh-Pits model • Architecture of ANN(single layer feed forward, multilayer feed forward, competitive network, recurrent network) • Back propagation Algorithm • Concepts of Deep Learning: Basics of CNN and RNN	6L
8	**Reinforcement Learning:** • Basic Concepts • Model based learning • Temporal difference based learning	3L
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand the methods involved in generating models from data
2	Understand a wide variety of learning algorithms
3	Understand how to evaluate models generated from data
4	Optimize the models learned and report on the expected accuracy that can be achieved when applying the models to solve the problems
5	Apply the machine learning algorithms to solve various real-world problems

Learning Resources:	
1	Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
2	Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)
3	Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007
4	Rajiv Chopra, Machine Learning, Khanna Publishing House, 2018
5	Ethem Alpaydin, Introduction to Machine Learning, Second Edition

Course Name:	**Biology**		
Course Code:	BS-BIO401	Category:	Basic Science Course
Semester:	Fourth	Credit:	2
L-T-P:	2-0-0	Pre-Requisites:	Basic knowledge of Physics, Chemistry and Mathematics
Full Marks:	100		

Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Bring out the fundamental differences between science and engineering
2	Discuss how biological observations of 18th Century that lead to major discoveries

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction to Biology:** To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry.	2L
2	**Classification System in Biology:** The underlying criterion, such as morphological, biochemical or ecological be highlighted. Hierarchy of life forms at phenomenological level. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. *E. coli, S. cerevisiae, D. melanogaster, C. elegance, A. thaliana, M. musculus.*	2L
3	**Genetics:** To convey that "Genetics is to biology what Newton's laws are to Physical Sciences" Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be given not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Importance of stem cell research.	2L
4	**Biomolecules**: To convey that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss	4L

	about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA.	
5	**Enzymes:** To convey that without catalysis life would not have existed on earth Enzymology: How to monitor enzyme catalysed reactions. How does an enzyme catalyse reactions? Discuss at least two examples.	2L
6	**Information Transfer:** The molecular basis of coding and decoding genetic information is universal Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination.	4L
7	**Macromolecular analysis:** How to analyse biological processes at the reductionist level Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.	4L
8	**Metabolism:** ATP as an energy currency. This should include the breakdown of glucose to CO_2 + H_2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO_2 and H_2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge.	2L
9	**Microbiology:** Concept of microscopic organisms. Concept of species and strains. Identification and classification of microorganisms. Sterilization and media compositions. Growth kinetics. Microscopy: simple, compound, phase-contrast, SEM, TEM, Confocal: principle and applications.	2L
Total		**24L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	State different engineering applications from biological perspective.
2	Classify biological systems and identify different organisms and microorganisms depending on their morphological, biochemical and ecological criterion.
3	Explain the concept of recessiveness and dominance during the passage of genetic material from parent to offspring and describe DNA as a genetic material in the molecular basis of information transfer.
4	Discuss structures of different biomolecules starting from basic units and hence understand different biological processes at the reductionistic level.

5	Describe protein structures and enzymology and also compare different mechanisms of enzyme action.
6	Describe energy transformation processes in biological systems.

Learning Resources:	
1	Biology for Engineers. Arthur T. Johnson. CRC Press.
2	Biology and Engineering of Stem Cell Niches. A K Vishwakarma and Jefferey Karp, Elsevier.
3	Environmental Biology for Engineers and Scientists. David A. Vaccari, P. P. Storm and J. F Alleman. ELBS
4	Biology for Engineers. G. K. Suraishkumar. Oxford

Course Name:	**Design and Analysis of Algorithms Lab**		
Course Code:	PC-IT492	**Category:**	Professional Core Courses
Semester:	Fourth	**Credit:**	2
L-T-P:	0-0-4	**Pre-Requisites:**	Data Structure & Algorithm
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	To develop skills to design and analyze fundamental algorithms
2	To strengthen the ability to identify and apply the suitable algorithm for the given real world problem
3	To gain knowledge in practical applications and role of computational complexity to determine the efficiency of an algorithm

Course Contents:

Module No.	Description of Topic/ Experiment	Contact Hrs.
1	**Divide and Conquer Methodology:** I. Implement Binary Search algorithm using recursive call to a function. II. Find Maximum and Minimum element of an array of integers using recursive call to a function. III. Implement Merge Sort algorithm using recursive call to a function. IV. Implement Quick Sort algorithm using recursive call to a function.	8P
2	**Dynamic Programming Technique :** I. Find the minimum number of scalar multiplications needed for	8P

	multiplying chain of matrices. II. Implement Traveling Salesman problem.	
3	**Greedy Methods:** I. Implement Knapsack Optimization problem. II. Implement optimization problem of Job Sequencing with Deadlines.	8P
4	**Graph Algorithm :** I. Implement Breadth First Search (BFS) algorithm. II. Implement Depth First Search (DFS) algorithm. III. Find the Minimum Cost Spanning Tree of a graph by applying Prim's algorithm. IV. Find the Minimum Cost Spanning Tree of a graph by applying Kruskal's algorithm. V. Implement Single Source shortest path finding algorithm for a graph proposed by Dijkstra. VI. Implement Single Source shortest path finding algorithm for a graph proposed by Bellman-Ford. VII. Implement all pair of shortest path finding algorithm of a graph proposed by Floyed & Warshall.	12P
5	**Branch and Bound Technique :** I. Implement 15-Puzzle problem.	4P
6	**Backtracking :** I. Implement the problem of placing 8 Queens on a chess board in non-attacking positions. II. Implement the problem of Coloring a Graph using minimum number of colors. III. Implement the algorithm for finding the presence of Hamiltonian cycle in a graph.	8P
Total		**48P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Design and analyze the time and space efficiency of the algorithm.
2	Identity and analyze the appropriate algorithm for given problem.
3	Have practical knowledge on the application of efficient algorithm.

Learning Resources:	
1	"Algorithm Design", 1ST Edition, Jon Kleinberg and Éva Tardos, Pearson.
2	"Algorithm Design: Foundations, Analysis, and Internet Examples", Second Edition,

	Michael T Goodrich and Roberto Tamassia, Wiley.
3	"Algorithms -- A Creative Approach", 3RD Edition, UdiManber, Addison-Wesley, Reading, MA
4	"Fundamentals Of Computer Algorithms", by Horowitz, Sahani, Universities Press

Course Name:	**Artificial Intelligence Lab**		
Course Code:	PC-AIML491	**Category:**	Professional Core Courses
Semester:	Fourth	**Credit:**	2
L-T-P:	0-0-4	**Pre-Requisites:**	Structured Programming
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	To develop skills to programming in Artificial Intelligence specific languages
2	To strengthen the ability to identify and apply the programming knowledge to implement fundamental algorithms of Artificial Intelligence
3	To gain knowledge in some famous practically operating Artificial Intelligent System

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	(i) Installation of gnu-prologue, Study of Prologue (gnu-prologue), its facts, and rules. (ii) Write simple facts for the statements and querying it.	12P
2	(i) Write a program for Family-tree. (ii) Write Program for Monkey-banana Problem. (iii)Write a program which behaves a small expert for medical Diagnosis. (iv)Write programs for computation of recursive functions like factorial Fibonacci numbers, etc. (v) Write program to solve 4-queens problem. (vi)Write a Program for water jug problem. (vii) Write a program for travelling salesman program.	28P
3	Case study of standard AI programs like MYCIN and AI Shell	8P
Total		**48P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Write progammes in Prologue (LISP / PYTHON can be used)

2	Learn how the well-known algorithms of AI can be implemented in programmes
3	Get idea how some famous artificial intelligent system works

Learning Resources:	
1	"Logic & Prolog Programming", Saroj Kaushik, New Age International
2	"GNU Emacs LISP Reference Manual", Bill Lewis
3	"Introduction to Machine Learning with Python", Andreas C. Muller

Course Name:	**Advanced Computing Lab**		
Course Code:	PC-AIML492	**Category:**	PC
Semester:	Fourth	**Credit:**	1.5
L-T-P:	0-0-3	**Pre-Requisites:**	Basic knowledge of probability and statistics and knowledge of python programming
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	To design and analyse various machine learning algorithms and techniques
2	Make students learn to use supervised and unsupervised learning paradigms of machine learning

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Lab 1: Programs using Data set, Mean, Median, Mode, Standard Deviation Lab 2: Program using Percentile, Data Distribution, Scatter Plot, Scale, Train/Test, Decision Tree	6P
2	Lab 3: Implementation of logical rules in Python Lab 4: Using appropriate data apply the concept of Linear Regression Lab 5: Using appropriate data apply the concept of Logistic Regression	9P
3	Lab 6 : Using appropriate data apply the concept of Gradient decent	3P
4	Lab 7: To add the missing value in any data set Lab 8: Perform & plot under in fitting & over fitting in a data set	6P

5	Lab 9: Implementation of clustering algorithms. Lab 10: Implementation of classification algorithms.	6P
Total		**30P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand the methods involved in generating models from data
2	Understand a wide variety of learning algorithms
3	Apply the machine learning algorithms to solve various real-world problems

Learning Resources:	
1	Machine Learning using Python, Manaranjan Pradhan, U Dinesh Kumar, Wiley
2	Introduction to Machine Learning with Python: A Guide for Data Scientists (Grey scale Indian Edition)

Course Name:	**Environmental Sciences**		
Course Code:	MC471	**Category:**	Basic Science Courses
Semester:	Fourth	**Credit:**	0
L-T-P:	2-0-0	**Pre-Requisites:**	Basic concepts of Environmental Science
Full Marks:	100		
Examination Scheme:	Semester Examination: 100		

Course Objectives:	
1	Purpose: We as human being are not an entity separate from the environment around us rather we are a constituent seamlessly integrated and co-exist with the environment around us. We are not an entity so separate from the environment that we can think of mastering and controlling it rather we must understand that each and every action of ours reflects on the environment and vice versa. Ancient wisdom drawn from Vedas about environment and its sustenance reflects these ethos. There is a direct application of this wisdom even in modern times.
2	Idea of an activity based course on environment protection is to sensitize the students on the above issues through following two types of activities.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**(a) Awareness Activities:** i) Small group meetings about any of the topic. ii) Slogan making event iii) Poster making event iv) Seminar on any of the topic. v) Preparation of a report on any of the topic regarding current scenario.	 4L 2L 5L 4L 4L
2	**(b) Actual Activities:** i) Plantation ii) Gifting a tree to see its full growth iii) Cleanliness drive iv) Drive for segregation of waste v) Shutting down the fans and ACs of the campus for an hour or so	5L
Total		**24L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain basic concepts, man, society & environment, their interrelationship, mathematics of population growth and associated problems, steady state conservation system.
2	Demonstrate natural environmental hazards like flood, earthquake, landslide-causes, effects and control/management.
3	Classify air pollution, water pollution, land pollution, noise pollution and their controls.
4	Study Elements of ecology and environmental management.

Learning Resources:	
1	M.P. Poonia & S.C. Sharma, Environmental Studies, Khanna Publishing House, New Delhi, 2019
2	Environmental science by Gillbert G. Master