

STATE BOARD OF TECHNICAL EDUCATION, BIHAR
Scheme of Teaching and Examination for
IVth SEMESTER DIPLOMA IN ARTIFICIAL INTELLIGENCE (AI) AND MACHINE LEARNING
(Effective from Session 2022-23 Batch)

THEORY

S.No	SUBJECTS	SUBJECT CODE	TEACHING SCHEME	EXAMINATION SCHEME							Credits
			Periods per week	Hours of Exam	Teacher's Assessment (TA) Marks (A)	Class Test (CT) Marks (B)	End Semester Exam. (ESE) Marks (C)	Total Marks (A+B+C)	Pass Marks ESE	Pass Marks in the Subject	
1.	Mathematics (Probability and Statistics)	2044401	03	03	10	20	70	100	28	40	03
2.	Operating System	2044402	04	03	10	20	70	100	28	40	03
3.	Introduction to Machine Learning	2044403	03	03	10	20	70	100	28	40	03
4.	Introduction to Artificial Intelligence	2044404	03	03	10	20	70	100	28	40	03
5.	Software engineering	2044405	04	03	10	20	70	100	28	40	03
Total : 17							350	500			15

PRACTICAL

S.No	SUBJECTS	SUBJECT CODE	TEACHING SCHEME	EXAMINATION SCHEME						Credits
			Periods per week	Hours of Exam	Practical (ESE)		Total Marks (PA+ESE)	Pass Marks in the Subject		
					Internal (PA)	External (ESE)				
6.	Operating system (UNIX/ LINUX) Lab	2044406	04 50% Physical 50% Virtual	03	15	35	50	20	02	
7.	Machine learning Lab	2044407	04 50% Physical 50% Virtual	03	15	35	50	20	02	
8.	Software engineering lab	2044408	04 50% Physical 50% Virtual	03	15	35	50	20	02	
Total: 12							150		06	

TERM WORK

S.No	SUBJECTS	SUBJECT CODE	TEACHING SCHEME	EXAMINATION SCHEME					
			Periods per week	Marks of Internal Examiner (PA)	Marks of External Examiner (ESE)	Total Marks (PA+ESE)	Pass Marks in the Subject	Credits	
9.	Minor Project I	2044409	02	15	35	50	20	01	
10.	Internship-I	2044410	(4 weeks)	10	30	40	16	01	
11.	Environmental science	2044411	02	10	--	10	04	01	
Total:-			04			100		03	
Total Periods per week of each duration One Hour = 33							Total Marks:750		24

MATHEMATICS (PROBABILITY AND STATISTICS)

SUBJECT CODE: 2044401	Theory			No. of period in one session: 42			Credits 03
	No. of Periods per Week			Full Marks:			
	L	T	P/S	ESE	:	70	
	03	-	-	T. A	:	10	
				C.T	:	20	

Course objectives:

This course should help the students understand the basic mathematical background of AI. Also, the students should be able to apply statistics and probability to analyse various datasets.

Course outcomes: After completion of course, students would be able to:

1. To understand the mathematical background of AI.
2. Use statistical methods to analyze and collect data.
3. Use probability and statistics to analyze data.
4. Use and apply hypothesis testing on different datasets.

CONTENTS: THEORY

Unit	Name of Topics	Hrs/week
Unit-I	Equations, Functions and Graphs Introduction to linear equations, Intercepts and slopes, System of equations, Exponentials, radicals and logarithms, Polynomials, Polynomial operations, Factorizations, Introduction to quadratic equations, Functions	08
Unit-II	Derivatives and Optimizations Rate of change, Introduction to limits, Continuity, finding limits, Differentiability, Derivative rules and operations, using derivatives to analyse functions, Second order derivatives, Optimization functions, Multivariate differentiation	08
Unit-III	Vectors and Matrices Introduction to vectors, Vector addition, vector multiplication, Introduction to matrices, matrix multiplication, properties of matrices, types of matrices, Matrix division, solving system of equations with matrices, Matrix transformations, Eigen values and eigen vectors, rank of matrix	08
Unit-IV	Probability Basic rules and axioms events, sample space, dependent and independent events, conditional probability, Random variables- continuous and discrete, expectation, variance, distributions- joint and conditional, Bayes' Theorem, Popular distributions- binomial, Bernoulli, poisson, exponential, Gaussian	10
Unit-V	Statistics Fundamentals of Data: Collection, Summarization, and Visualization; Sampling and Sampling Distributions, Central Limit Theorem; Methods of Estimation, Unbiased estimators; Confidence Interval Estimation: Z-interval, t-interval; Hypothesis Testing, Types of Errors, Rejection Region Approach and p-value Approach.	08

Reference Books:

1. Basic Mechanical Engineering – M.P. Poonia & S.C. Sharma, Khanna Publishing House, Delhi
2. Elements of Mechanical Engineering – M. L. Mathur, F. S. Mehta and R. P. Tiwari, Jain Brothers, New Delhi
3. Engineering Heat Transfer – Gupta & Prakash, Nem Chand & Brothers, New Delhi
4. Workshop Technology (Vol. 1 and 2) – B. S. Raghuvanshi, Dhanpath Rai and Sons, New Delhi.
5. Basic Mechanical Engineering – J Benjamin
6. Elements of Mechanical Engineering – Roy and Choudhary
7. Engineering Thermodynamics – Spalding and Cole

OPERATING SYSTEM

SUBJECT CODE: 2044402	Theory			No. of period in one session: 45			Credits
	No. of Periods per Week			Full Marks:		:	100
	L	T	P/S	ESE	:	70	03
	04	-	-	T. A	:	10	
				C.T	:	20	

Course Learning Objective:

The course provides the students with an understanding of human computer interface existing in computer system and the basic concepts of operating system and its working. Further, good working knowledge to work in Windows and Unix environments is provided by this course.

Course Outcomes:

The objectives of this course are to make the students able to

1. To teach the requirement of Operating System in Computers.
2. Explain Windows Operating System and to make familiar with special features of Windows Operating System.
3. Understand multi-user Operating System Unix Operating System and Unix FileStructure.

Contents: Theory		Hrs.
<u>Unit – 1</u>	<p>Introduction to operating system:</p> <p>An Introduction to O.S & its services, Evolution of O.S, various types of O.S, Batch Processing, Multiprogramming, Multiprocessing, Multitasking, Operation system structure. Concepts of: Process – files – system calls – Interrupt – shell. Introduction to Unix, Shell commands.</p>	[5]
<u>Unit – 2</u>	<p>Process Management:</p> <p>An Introduction to process, process state & Transition, Process control Block, Process Context, Context switch.</p>	[4]
<u>Unit – 3</u>	<p>Process Scheduling:</p> <p>(Pre-emptive & Non-pre-emptive Algorithms), FCFS (First Come First Served) Algorithm, Shortest Job First, Priority Scheduling, Round Robin Scheduling. Performance criteria of scheduling Algorithm, CPU utilization, throughput, Turnaround time, waiting time, Response time. Overview of: Inter-process communication – Race condition critical section, Semaphores.</p>	[06]

<u>Unit – 4</u>	Deadlock: Introduction to Deadlock, Necessary condition for Deadlock, Method for Handling Deadlock, Brief overview of Deadlock prevention, Deadlock Avoidance (Banker’s Algorithm), Deadlock Detection & Recovery.	[08]
<u>Unit – 5</u>	Memory Management: Introduction to Memory management, Contiguous allocation, Fixed Partition, Dynamic partition, Non-contiguous allocation – paging, segmentation. Introduction to Virtual-memory management – Demand paging, Cop-on-write, page replacement, Allocation of frames, Thrashing.	[10]
<u>Unit – 6</u>	Files and protection: Introduction to file systems – File system design, Access methods – sequential, Direct, Swapping, File allocation methods OS-security: Authentication, Access control, Access Rights, System logs, Protection.	[06]

NPTEL/SWAYAM Course (if any):

S. No.	Course Name	Instructor	Host Institute
1.	Operating System Fundamentals	Prof.Santanu Chattopadhyay	IIT Kharagpur
2.	Operating System	Prof. Sorav Bansal	IIT Delhi

Text Books/Suggested References:

1. Operating system, Galvin & Silberschatz, 7th Edition, John Willey 2004
2. Operating Systems-A Concept Based Approach, Dhamdhare, TMH 2006
3. Operating System Concepts, Ekta Walia, Khanna Book Publishing 2020.
4. Operating systems Internals and design principles By William Stallings, Pearson Education, 2012
5. Operating Systems –A Design Oriented Approach, Crowley, TMH, 2001

INTRODUCTION TO MACHINE LEARNING

SUBJECT CODE: 2044403	Theory			No. of period in one session: 42			Credits
	No. of Periods per Week			Full Marks:		:	100
	L	T	P/S	ESE	:	70	03
	03	-	-	T. A	:	10	
				C.T	:	20	

Course Learning Objective:

The students will understand the basics of Machine Learning. They will also learn and will be able to apply different machine learning models to various datasets.

Course Outcomes:

The objectives of this course are to make the students able to

1. Understand basic applications and issues of Machine Learning
2. Understand the different types of datasets
3. Analyze and work with different datasets
4. Analyze various Machine Learning techniques and algorithms
5. Apply various algorithms to different datasets.

Contents: Theory		Hrs.
Unit – 1	<p>Introduction</p> <p>Introduction and definition of Machine Learning, Introduction of Networks, Datasets and their handle, Feature sets, Dataset division: test, train and validation sets, cross validation.</p>	[08]
Unit – 2	<p>Basics of machine learning</p> <p>Applications of Machine Learning, processes involved in Machine Learning, Introduction to Machine Learning Techniques: Supervised Learning, Unsupervised Learning and Reinforcement Learning, Real life examples of Machine Learning.</p>	[08]
Unit – 3	<p>Supervised learning</p> <p>Classification and Regression: K-Nearest Neighbor, Linear Regression, Logistic Regression, Support Vector Machine (SVM), Evaluation Measures: SSE, MME, R2, confusion matrix, precision, recall, F-Score, ROC-Curve.</p>	[08]

Unit – 4	Unsupervised learning Introduction to clustering, Types of Clustering: Hierarchical, Agglomerative Clustering and Divisive clustering; Partitional Clustering - K-means clustering.	[8]
Unit – 5	Miscellaneous Dimensionality reduction techniques: PCA, LDA, ICA. Introduction to Deep Learning, Gaussian Mixture Models, Natural Language Processing, Computer Vision.	[10]

NPTEL/SWAYAM Course (if any):

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Introduction to Machine Learning	Prof. Balaraman Ravindran	IIT Madras
2.	Machine Learning	Prof. Carl Gustaf Jansson	KTH, The Royal Institute of Technology

Text Books/Suggested References:

1. Introduction to Machine Learning, By Jeeva Jose, Khanna Book Publishing Co., 2020.
2. Machine Learning for Dummies, By John Paul Mueller and Luca Massaron, For Dummies, 2016.
3. Machine Learning, By Rajeev Chopra, Khanna Book Publishing Co., 2021.
4. Machine Learning: The New AI, By Ethem Alpaydin, The MIT Press, 2016.
5. Machine Learning, Tom M. [Mitchell, McGraw Hill Education, 2017.](#)
6. <https://www.udacity.com/course/intro-to-machine-learning--ud120>
7. <https://www.coursera.org/learn/machine-learning-duke>

INTRODUCTION TO ARTIFICIAL INTELIGENCE

SUBJECT CODE: 2044404	Theory			No. of period in one session: 42			Credits 03
	No. of Periods per Week			Full Marks:			
	L	T	P/S	ESE	:	100	
	03	-	-	T. A	:	70	
				C.T	:	10	
				:	20		

Course Learning Objective:

Students will learn the basic concepts and techniques of Artificial Intelligence. They should be able to develop AI algorithms for solving practical problems.

Course Outcomes:

The objectives of this course are to make the students able to

1. Understand the basic concepts and techniques of Artificial Intelligence.
2. Apply AI algorithms for solving practical problems
3. Describe human intelligence and AI
4. Explain how intelligent system works.
5. Apply basics of Fuzzy logic and neural networks.
6. Explain Expert System and implementation

Contents: Theory		Hrs.
<u>Unit – 1</u>	<p><u>Introduction</u> Artificial Intelligence and its applications, Artificial Intelligence Techniques, Level of models, criteria of success, Intelligent Agents, Nature of Agents, Learning Agents. AI Techniques, advantages, and limitations of AI, Impact and Examples of AI, Application domains of AI. The AI Ladder - The Journey for Adopting AI Successfully, Advice for a career in AI, Hotbeds of AI Innovation.</p>	[10]
<u>Unit – 2</u>	<p><u>Problem solving techniques</u> State space search, control strategies, heuristic search, problem characteristics, production system characteristics., Generate and test, Hill climbing, best first search, A* search, Constraint satisfaction problem, Mean-end analysis, Min-Max Search, Alpha-Beta Pruning, Additional refinements, Iterative Deepening.</p>	[08]
<u>Unit – 3</u>	<p><u>Logic</u> Propositional logic, predicate logic, Resolution, Resolution in propositional logic and predicate logic, Clause form, unification algorithm,</p>	[06]

<u>Unit – 4</u>	<u>Knowledge Representation schemes and reasoning</u> Mapping between facts and representations, Approaches to knowledge representation, procedural vs declarative knowledge, Forward vs. Backward reasoning, Matching, conflict resolution, Non- monotonic reasoning, Default reasoning, statistical reasoning, fuzzy logic Weak and Strong filler structures, semantic nets, frame, conceptual dependency, scripts	[10]
<u>Unit – 5</u>	<u>Planning</u> The Planning problem, planning with state space search, partial order planning, planning graphs, planning with propositional logic, Analysis of planning approaches, Hierarchical planning, conditional planning, Continuous and Multi Agent planning.	[08]

NPTEL/SWAYAM Courses

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	An Introduction to Artificial Intelligence	Prof. Mausam	IIT Delhi
2.	Artificial Intelligence	Prof. Sudeshna Sarkar	IIT Kharagpur

TextBooks/Suggested References:

1. A Classical Approach to Artificial Intelligence, M.C. Trivedi, Khanna Book Publishing, 2019.
2. Artificial Intelligence: A modern approach by Stuart Russel, Pearson Education, 2010.
3. Artificial Intelligence by Rich and Knight, The McGraw Hill, 2017.
4. Artificial Intelligence: A new synthesis by Nils and Nilson, Elsevier, 1997.
5. Artificial Intelligence by Luger, Pearson Education, 2002.
6. Artificial Intelligence by Padhy, Oxford Press, 2005.
7. <https://www.edx.org/course/artificial-intelligence-ai>
8. <https://www.udemy.com/course/artificial-intelligence-az/>

SOFTWARE ENGINEERING

SUBJECT CODE: 2044405	Theory			No. of period in one session: 42			Credits 03
	No. of Periods per Week			Full Marks:	:	100	
	L	T	P/S	ESE	:	70	
	04	-	-	T. A	:	10	
				C.T	:	20	

Course Learning Objective:

Students should learn the concept and importance of Software Engineering. They should be able to construct software that is reasonably easy to understand, modify, maintain and reliable. They should learn strengths and weaknesses of various Software Engineering Techniques used in industrial applications.

Course Outcomes:

The objectives of this course are to make the students able to

1. Understand the process of designing, creating and maintaining software.
2. Create softwares for various application domains.
3. Understand the importance of software design and development practices
4. Understand the challenges of large scale software development.

Contents: Theory		Hrs.
<u>Unit – 1</u>	<p><u>Introduction and Software Process Models</u></p> <p>Software, Software Engineering, Myths, Software Process, Work Products, Importance of Software Engineering, Standard for Software Process, Waterfall Model, Prototyping Model, Iterative Enhancement Model, Spiral Model, RAD model, 4th Generation models, Formal Methods, Agile Development</p>	[8]
<u>Unit – 2</u>	<p><u>Requirement Engineering and Software Project Management</u></p> <p>Software Requirements, Types of Requirements, Requirement Engineering Cycle, Requirements Specification document, Characteristics of Requirements, Requirement verification and validation, Role of Management in Software Development, Project Estimation Techniques, Staffing, Scheduling, Earned Value Analysis, Software Risks, Software Configuration Management, Software Process and Project metrics.</p>	[10]

<u>Unit – 3</u>	<p><u>Software Design and Coding</u></p> <p>Process, Data and Behavioural Modelling, Design Concepts, Modularity, Architectural design, Coupling and Cohesion, Top-down and bottom-up design, Object-oriented Analysis, Function- oriented and Object-Oriented Design approach, Software Design Document, Coding styles and documentation,</p>	[06]
------------------------	---	------

<u>Unit – 4</u>	<p><u>Testing and Software Quality</u></p> <p>Testing principles, testing strategies, Black-box and White-box Testing Techniques, Levels of testing -unit, integration, system, regression, Test Plan, Test Cases Specification, Software debugging, Software Maintenance, Software Quality Assurance (SQA), SQA tasks, Software amplification and removal, Formal Technical Reviews, Software Quality Factors, ISO 9126, SEI CMM, CMMI, Software Reliability. Software Availability.</p>	[10]
<u>Unit – 5</u>	<p><u>Computer Aided Software Engineering and Advanced Topics</u></p> <p>Computer Aided Software Engineering (CASE) and its Scope, CASE support in Software Life Cycle, Architecture of CASE Environment, Upper CASE and Lower CASE, Exposure to CASE tools. Software Process Improvement, Component Based Software Engineering, Web Engineering, Reverse Engineering, Software Engineering challenges of Big Data, Mobile Applications.</p>	[08]

Alternative NPTEL/SWAYAM Course (if any):

S. No.	Course Name	Instructor	Host Institute
1.	Software Engineering	Prof. Rajib Mall	IIT Kharagpur
2.	Software Engineering - Video course	Prof. N.L. Sarda, Prof. Rushikesh K Joshi, Prof. Umesh Bellur	IIT Bombay

Text Books/Suggested References:

1. Software Engineering-A Practitioners Approach, By R. Pressman, McGraw Hill International edition, 2004
2. Software Engineering, N.S. Gill, Khanna Publishing Co., Delhi 2018.
3. Software Engineering, Ian Sommerville, Addison-Wesley, 2010
4. An Integrated Approach to Software Engineering, Pankaj Jalote, Narosa, 2014
5. Fundamentals of Software Engineering, By Rajib Mall, PHI Learning Pvt. Ltd, 2014
6. Software Engineering (3rd ed.), By K.K Aggarwal & Yogesh Singh, New Age International Publishers, 2007

OPERATING SYSTEM LAB

SUBJECT CODE: 2044406	Practical			No. of period in one session: 52			Credits 02
	No. of Periods per Week			Full Marks:			
	L	T	P/S	Internal (PA)	:	50	
	-	-	04	External (ESE)	:	15	
				:	35		

Course Objective:

- To familiarize students with the architecture of Unix OS.
- To provide necessary skills for developing and debugging programs in UNIX environment.

Practical Outcomes:

After completion of the course the student would be able to

- Appreciate the advantages of Unix OS.
- Develop and debug, C programs created on UNIX platforms.
- Use and if necessary, install standard libraries.

CONTENTS		Hrs.
1.	To perform shell programming.	[10]
2.	Implement memory management techniques like paging or segmentation.	[8]
3.	Implement any file allocation technique (Linked, Indexed or Contiguous).	[10]
4.	Use the following system calls of UNIX operating system: mkdir, rmdir, link, unlink, mount, umount, users +, chown, chmod, getuid, setuid.	[10]
5.	Use the following system calls of UNIX operating system: fork, wait, exec, exit, kill, getpid, brk, nice, sleep, trace, open, close, read, write, lseek, stat, sync	[8]
6.	Use the following system calls of UNIX operating system: signals, pipe, socket, accept, snd, recv, connect.	[08]

Text Books/Suggested References:

1. Operating System Concepts, Silberschatz, Abraham and Galvin, Peter, Wiley India Limited
2. UNIX Concepts and Applications, Sumitabha Das, McGraw-Hill Education
3. Operating System Concepts, Ekta Walia, Khanna Publishing House
4. B.A. Forouzan, "Local Area Networks", TMH. 2002
5. B.A. Forouzan, "TCP/IP Protocol Suite", TMH.2004

MACHINE LEARNING LAB

SUBJECT CODE: 2044407	Practical			No. of period in one session: 56			Credits 02	
	No. of Periods per Week			Full Marks:				50
	L	T	P/S	Internal (PA)				15
	-	-	04	External (ESE)				35

Course Objective:

The students will understand the basics of Machine Learning. They will also learn and will be able to apply different machine learning models to various datasets.

Practical Outcomes:

After completing the course, the students will understand-

1. Understand basic applications and issues of Machine Learning
2. Understand the different types of datasets
3. Analyze and work with different datasets
4. Analyze various Machine Learning techniques and algorithms
5. Apply various algorithms to different datasets.

CONTENTS: Practical		Hrs.
01	Python Introduction:	[10]
02	Loops and Conditions and other preliminary stuff,	[8]
03	Functions, Classes and Modules,	[8]
04	Exceptions, Database access,	[10]
05	Mathematical computing with Python packages like: numpy, Matplotlib, pandas Tensor Flow, Keras	[8]
06	Implement basic ML models like SVM, KNN, K-Means, Logistic Regression, LinearRegression	[12]

Text Books/Suggested References:

1. Introduction to Machine Learning, By Jeeva Jose, Khanna Book Publishing Co., 2020.
2. Machine Learning for Dummies, By John Paul Mueller and Luca Massaron, For Dummies, 2016.
3. Machine Learning, By Rajeev Chopra, Khanna Book Publishing Co., 2021.
4. Machine Learning: The New AI, By Ethem Alpaydin, The MIT Press, 2016.
5. Machine Learning, Tom M. [Mitchell, McGraw Hill Education, 2017.](#)
6. <https://www.udacity.com/course/intro-to-machine-learning--ud120>
7. <https://www.coursera.org/learn/machine-learning-duke>

SOFTWARE ENGINEERING LAB

SUBJECT CODE: 2044408	Practical			No. of period in one session: 52			Credits
	No. of Periods per Week			Full Marks:	:	50	02
	L	T	P/S	Internal (PA)	:	15	
	-	-	04	External (ESE)	:	35	

Course Learning Objective:

Students should learn the concept and importance of Software Engineering. They should be able to construct software that is reasonably easy to understand, modify, maintain and reliable. They should learn strengths and weaknesses of various Software Engineering Techniques used in industrial applications.

Objective:

The objectives of this course are to make the students able to

1. Understand the process of designing, creating and maintaining software.
 2. Create software's for various application domains.
 3. Understand the challenges of large-scale software development.
1. Understand the importance of software design and development practices

CONTENTS: Practical		Hrs.
1	Perform Programming Exercises for software design concepts.	[12]
2	Perform Programming Exercises for software testing concepts.	[12]
3	Perform Programming Exercises for Project Management concepts.	[10]
4	Design and Develop UML diagrams for any Software Project.	[10]
5	Perform Project Development with Software Engineering practices.	[8]

Text Books/Suggested References:

1. Software Engineering-A Practitioners Approach, By R. Pressman, Mc Graw Hill International edition, 2004
2. Software Engineering, N.S. Gill, Khanna Publishing Co., Delhi 2018.
3. Software Engineering, Ian Sommerville, Addison-Wesley, 2010
4. An Integrated Approach to Software Engineering, Pankaj Jalote, Narosa, 2014
5. Fundamentals of Software Engineering, By Rajib Mall, PHI Learning Pvt. Ltd, 2014
6. Software Engineering (3rd ed.), By K.K Aggarwal & Yogesh Singh, New Age International Publishers, 2007

MINOR PROJECT-I

SUBJECT CODE: 2044409	TW			No. of period in one session: 32			Credits 01
	No. of Periods per Week			Full Marks:	:	50	
	L	T	P/S	Internal (PA)	:	15	
	-	-	02	External (ESE)	:	35	

Course Learning Objective:

This course is aimed to provide more weightage for project work. The project work could be done in the form of a project by using the application of Artificial intelligence (AI) in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative AI-based projects could be encouraged under this course.

INTERNSHIP I (4 WEEKS) (T.W)

SUBJECT CODE: 2044410	Term Work						Credits
	No. of Periods per Week			Full Marks:	:	40	01
	L	T	P/S	Internal (PA)	:	10	
		-	04 Weeks	External (ESE)	:	30	

ENVIRONMENT SCIENCE (TERM WORK)

SUBJECT CODE: 2044411	TW			No. of period in one session: 30			Credits 01
	No. of Periods per Week			Full Marks:	:	10	
	L	T	P/S	Internal	:	10	
	-	-	02		:		

Course Objective: People working in industries or elsewhere essentially require the knowledge of environmental science so as to enable them to work and produce most efficient, economical and eco-friendly finished products.

- Solve various engineering problems applying ecosystem to produce eco – friendly products.
- Use relevant air and noise control method to solve domestic and industrial problems.
- Apply relevant water and soil control method to solve domestic and industrial problems.
- To recognize relevant energy sources required for domestic and industrial applications.
- Analyze local solid and e-waste problems.

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

1. Understand the ecosystem and terminology and solve various engineering problems applying ecosystem knowledge to produce eco – friendly products.
2. Understand the suitable air, extent of noise pollution, and control measures and acts.
3. Understand the water and soil pollution, and control measures and acts.
4. Understand different renewable energy resources and efficient process of harvesting.
5. Understand solid Waste Management, ISO 14000 & Environmental Management.

CONTENTS: TERM WORK		Hrs.
1	<p>Ecosystem</p> <ul style="list-style-type: none"> • Structure of ecosystem, Biotic & Abiotic components. • Food chain and food web. • Aquatic (Lentic and Lotic) and terrestrial ecosystem. • Carbon, Nitrogen, Sulphur, Phosphorus cycle. • Global warming -Causes, effects, process, Green House Effect, Ozone depletion. 	[08]
2	<p>Air and, Noise Pollution</p> <ul style="list-style-type: none"> • Definition of pollution and pollutant, Natural and manmade sources of air pollution (Refrigerants, I.C., Boiler). • Air Pollutants: Types, Particulate Pollutants: Effects and control (Bag filter, Cyclone 	[10]

	<p>separator, Electrostatic Precipitator).</p> <ul style="list-style-type: none"> • Gaseous Pollution Control: Absorber, Catalytic Converter, Effects of air pollution due to Refrigerants, I.C., Boiler. • Noise pollution: sources of pollution, measurement of pollution level, Effects of Noise pollution, Noise pollution (Regulation and Control) Rules, 2000. 	
3	<p>Water and Soil Pollution</p> <ul style="list-style-type: none"> • Sources of water pollution, Types of water pollutants, Characteristics of water pollutants Turbidity, pH, total suspended solids, total solids BOD and COD: Definition, calculation. • Waste Water Treatment: Primary methods: sedimentation, froth floatation, Secondary methods: Activated sludge treatment, Trickling filter, Bioreactor, Tertiary Method: Membrane separation technology, RO (reverse osmosis). • Causes, Effects and Preventive measures of Soil Pollution: Causes-Excessive use of Fertilizers, Pesticides and Insecticides, Irrigation, E-Waste. 	[10]
4	<p>Renewable sources of Energy</p> <ul style="list-style-type: none"> • Solar Energy: Basics of Solar energy. Flat plate collector (Liquid & Air). Theory of flat plate collector. Importance of coating. Advanced collector. Solar pond. Solar water heater, solar dryer. Solar stills. • Biomass: Overview of biomass as energy source. Thermal characteristics of biomass as fuel. Anaerobic digestion. Biogas production mechanism. Utilization and storage of biogas. • Wind energy: Current status and future prospects of wind energy. Wind energy in India. Environmental benefits and problem of wind energy. • New Energy Sources: Need of new sources. Different types new energy sources. Applications of (Hydrogen energy, Ocean energy resources, Tidal energy conversion.) Concept, origin and power plants of geothermal energy. 	[12]

5	<p>Solid Waste Management, ISO 14000 & Environmental Management</p> <ul style="list-style-type: none"> • Solid waste generation- Sources and characteristics of: Municipal solid waste, E-waste,biomedical waste. • Metallic wastes and Non-Metallic wastes (lubricants, plastics, rubber) from industries. Collection and disposal: MSW (3R, principles, energy recovery, sanitary landfill), Hazardous waste. • Air quality act 2004, air pollution control act 1981 and water pollution and control act1996. Structure and role of Central and state pollution control board. • Concept of Carbon Credit, Carbon Footprint. • Environmental management in fabrication industry. • ISO14000: Implementation in industries, Benefits. 	[12]
---	---	------

Text Books/References:

1. S.C. Sharma & M.P. Poonia, Environmental Studies, Khanna Publishing House, New Delhi.
2. C.N. R. Rao, Understanding Chemistry, Universities Press (India) Pvt. Ltd., 2011.
3. Arceivala, Soli Asolekar, Shyam, Waste Water Treatment for Pollution Control and
4. Reuse, Mc-Graw Hill Education India Pvt. Ltd., New York, 2007, ISBN:978-07-062099-062099-
5. Nazaroff, William, Cohen, Lisa, Environmental Engineering Science, Willy, New York, 2000,ISBN 10: 0471144940.
6. O.P. Gupta, Elements of Environmental Pollution Control, Khanna Publishing House, NewDelhi
7. Rao, C. S., Environmental Pollution Control and Engineering, New Age InternationalPublication, 2007, ISBN: 81-224-1835-X.
8. Rao, M. N.Rao, H.V.N, Air Pollution, Tata Mc-Graw Hill Publication, New delhi, 1988, ISBN:0-07- 451871-8.
9. Frank Kreith, Jan F Kreider, Principles of Solar Engineering, McGraw-Hill, New York; 1978,ISBN: 9780070354760.
10. Aldo Vieira, Da Rosa, Fundamentals of renewable energy processes, Academic PressOxford, UK; 2013. ISBN: 9780123978257.
11. Patvardhan, A.D, Industrial Solid Waste, Teri Press, New Delhi, 2013, ISBN:978-81-7993-502-6
12. Metcalf & Eddy, Waste Water Engineering, Mc-Graw Hill, New York, 2013, ISBN:077441206.
13. eshav Kant, Air Pollution & Control, Khanna Publishing House, New Delhi (Edition 2018)