


Open Elective Courses-AR 21

Open Elective Courses Syllabus



GMR Institute of Technology
Rajam 532 127, Andhra Pradesh
Accredited by NAAC & NBA

Open Electives - AR21 Regulations

No.	Course Code	Course	POs	L	T	P	Credits
1	21CE001	Disaster Management	2,7	3	-	-	3
2	21EE001	Electrical Installation, Safety and Auditing	2,3,6,8	3	-	-	3
3	21ME001	Fundamentals of Optimization Techniques	1,2,3,5	3	-	-	3
4	21EC001	Sensors for Engineering Applications	1	3	-	-	3
5	21CS001	Fundamentals of Artificial Intelligence	1,2,3	3	-	-	3
6	21CH001	Energy Conversion and Storage Devices	1,3,6,7	3	-	-	3
7	21IT001	Fundamentals of Multimedia	3,5,7	3	-	-	3
8	21BS001	Nano Materials and Technology	1,12	3	-	-	3
9	21DS001	Fundamentals of Data Science	1,2	3	-	-	3
10	21CE002	Air Pollution and Environmental Impact Assessment	6,7,12	3	-	-	3
11	21EE002	Renewable Energy Sources	2,7	3	-	-	3
12	21ME002	Principles of Entrepreneurship	1,5,8,11	3	-	-	3
13	21EC002	Electronics for Agriculture	1,2	3	-	-	3
14	21CS002	Fundamentals of Machine Learning	2,5	3	-	-	3
15	21CH002	Industrial Safety and Hazard Management	1,2,3,6,8	3	-	-	3
16	21IT002	Fundamentals of Cloud Computing	2,6,7,8,12	3	-	-	3
17	21BS002	Advanced Numerical Techniques	1,2	3	-	-	3
18	21BS003	Functional Materials and Applications	1,7	3	-	-	3
19	21CE003	Solid Waste Management	3,7,12	3	-	-	3
20	21EE003	Fundamentals of Electrical Vehicle Technology	2,3,12	3	-	-	3
21	21ME003	Industrial Engineering and Management	1,11	3	-	-	3
22	21EC003	Interfacing and Programming with Arduino	1,2	3	-	-	3
21	21CS003	Data Science for Engineering Applications	2,3,4	3	-	-	3
24	21CH003	Industrial Ecology for Sustainable Development	2,6,7	3	-	-	3
25	21IT003	Fundamentals of Mobile Computing	1,7	3	-	-	3
26	21BS004	Advanced Materials of Renewable Energy	1,7	3	-	-	3
27	21BS005	Applied Linear Algebra for Engineers	1,12	3	-	-	3
28	21CE019	Green Buildings	1,7,12	3	-	-	3
29	21EE017	Sustainable Energy	2,3,12	3	-	-	3
30	21ME019	Total Quality Management	1,11	3	-	-	3
31	21EC011	Communication Technologies	1,2	3	-	-	3
32	21CS020	Applications of Artificial Intelligence	2,3,6,7	3	-	-	3
33	21CH016	Green Technologies	2,6,7	3	-	-	3
34	21IT015	Human Computer Interaction	1,7	3	-	-	3
35	21BS006	Handling of Industrial waste and waste water	1,7	3	-	-	3
36	21OE001	Robotics and Automation	5,6,7	3	-	-	3
37	21OE002	Introduction to IoT	1,2	3	-	-	3
38	21OE003	Fundamentals of Image processing	1,2	3	-	-	3
39	21OE004	Fundamentals of Data Acquisition systems	1,2	3	-	-	3
40	21OE005	Airport Operations Management	2,4,11,12	3	-	-	3
41	21OE006	Fundamentals of Embedded Systems	1,2	3	-	-	3
42	21OE007	Remote Sensing and GIS	1,2,5,7,10	3	-	-	3
43	21OE008	Big Data Analytics	1,7	3	-	-	3
44	21OE009	Fundamentals of Cyber Security	3,6,8	3	-	-	3
45	21OE010	Smart Cities	7,12	3	-	-	3
46	21OE011	Nano Materials and Thin Film Technology	1,12				
47	21CSMC1	Cloud computing	2,3	3	-	-	3
48	21CSMC2	Ethical Hacking	1,2,3	3	-	-	3
49	21CSMC3	Fundamentals of Web Development	2,3,5	4	-	-	4
50	21OE012	Business Intelligence & Analytics	2,3,5	3	-	-	3
51	21OE013	Introduction To Industry 4.0 And Industrial IoT	2,3	3	-	-	3
52	21OE014	Natural Language Processing	2,3	3	-	-	3
53	21OE015	Affective Computing	1,2,3,4	3	-	-	3
54	21OE016	Principles of Data Science	1,2	3	-	-	3
55	21OE017	Data Structure and Algorithms using Java	1,2,3,4,5,12	3	-	-	3
56	21OE018	The Joy of Computing Using Python	1,2,3,4,5,12	3	-	-	3
57	21OE019	Programming in Modern C++	1,2,3,4,5,12	3	-	-	3
58	21OE020	Cyber Security and Privacy	1,2,3,4,6	3	-	-	3

59	21OE021	Fundamentals of Computer Vision	1,2,3,12	3	-	-	3
60	21OE022	Data Visualization Techniques	1,2,3,5,10	3	-	-	3
61	21OE023	Occupational Health and Industrial Hygiene	1,3,6,8,10,12	3	-	-	3
62	21OE024	Safety in Engineering Industries	1,3,6,8,10,12,	3	-	-	3
63	21OE025	Reliability Engineering and Integrated Management Systems	1,3,6,8,10,12,	3	-	-	3
64	21OE026	Time Series Data Analysis and Modelling	1,2,3,10,12	3	-	-	3
65	21OE027	Artificial Intelligence for Business Intelligence	1,2,3,5,12	3	-	-	3

Course outcomes

1. Build knowledge about need and importance of hazard management in the concern field
2. Understand the causes of Natural and Manmade disasters
3. Discuss the mitigation measures for Natural and Manmade disasters
4. Understand the importance of science and technology in disaster risk management
5. Build knowledge on importance of authorities and their risk management
6. Understand the scenarios of various disasters and mitigation

COs-POs Mapping

COs	PO2	PO7
1	2	2
2	3	3
3	3	2
4	3	3
5	1	2
6	1	3

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I**Introduction to Disaster Management**

Components of disaster management-Organizational structure for disaster management-Disaster management schemes- Disaster Risk Reduction-Global Policies and Practices - Basic Strategies and Practices of Disaster Reduction- Disaster Risk Reduction with Global Framework.

Role of Government and NGO Bodies, Role of Engineers on Disaster Management.

12+3 Hours

Unit II**Natural and Manmade Disasters**

Management of Natural Disasters: Floods, Droughts, Earthquakes, Global Warming, Cyclones, Landslides, Tsunamis Causes, effects, mitigation. Effects on poverty, Climate Change and Human Health.

Management of Manmade Disasters: Solid waste, Fire, Bio-terrorism, Emerges infectious diseases, Transportation Accidents, Structural failures Causes, effects, mitigation.

Volcanic eruptions, mining.

11+4 Hours

Unit III**Science and Technology in Disaster Management**

Implementation of Technology for Infrastructure, Disaster Management for Infrastructure, Geospatial Information in Agriculture Drought Assessment and Monitoring. Multimedia Technology in Disaster Risk Management Training, Disaster Communication System (Early Warning and its Dissemination) - Essentials of School Disaster Education, Community based Disaster Management.

Role of IT in Disaster Preparedness, Role of Educational Institute

11+4Hours

Unit IV**Disaster Risk Management in India and Case Studies**

Disaster Management Indian scenario - India's vulnerability profile - Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders, Policies and legislation for disaster risk reduction, DRR programs in India and the activities of National Disaster Management Authority.

Cases Studies: Natural Disaster -Floods, Earthquakes, Cyclones, Tsunamis. Manmade Disaster: Industrial Accidents, Transportation Accidents and Terrorism & Bio-terrorism.

Droughts, Nuclear Disaster.

11+4Hours

Total: 45+15Hours

Text Book(s):

1. Disaster management - Global Challenges and local solution, Edited by Rajibshash and R.R.Krishnamurthy (2009) published by universities press
2. Disaster management - future challenges and opportunities (2007) editor by Jagbirsingh. Published by I K international Publishing house pvt.Ltd.
3. Disaster management, (2021), editor by R. Subramanian, Vikas Publishing, Noida.

Reference Book(s):

1. Disaster management edited by H K Gupta (2013) published by universities press.

Sample Question (S)**Internal Assessment Pattern**

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	40	40	40
Understand	60	60	60
Apply	--	--	
Analyze	--	--	--
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. What are the different phases of disaster management cycle?
2. "Prevention is better than cure is opted proverb in the context of disaster management" Explain.
3. How do you frame a system to overcome the risk occurred by a new hazard. **(For Open Book Examination and not for semester end examination)**

Understand

1. Explain the causes of global warming.
2. Explain the difference between environmental and social vulnerabilities.
3. How do you give frame a system for a three kinds of natural disasters? **(For Open Book Examination and not for semester end examination)**

Course Outcomes

1. Summarize the concepts of estimation and costing
2. Select a suitable wiring system for domestic and industrial applications
3. Identify the safety standards in residential, commercial and agricultural applications
4. Explain the energy demand and supply, energy crisis and future energy scenario
5. Illustrate Energy management techniques and perform energy audit
6. Explain various energy management measuring devices and tools

COs - POs Mapping

COs	PO ₂	PO ₃	PO ₆	PO ₈
1	2	2	2	2
2	3	3	3	3
3	3	3	3	3
4	2	2	2	2
5	2	2	2	2
6	2	2	2	2

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I**Principles of estimation and design of domestic & industrial wiring**

Purpose of estimating and costing, Elements of estimating & costing, Tender Document, Purchase systems, Overhead charges, Labour charges, contingencies. Types of wires, types of wiring systems, selection of wire, wiring accessories and protective devices

IE rules for Domestic & Industrial wiring, estimate for single store yard, Estimate for a small workshop

Estimation of power wiring systems

(11+4Hours)

UNIT-II**Safety in residential, commercial, agricultural, installation of plant & Protective tools equipment**

Electricity, its Usefulness and Hazards, statutory Provisions, Indian Standards, Effects of Electrical parameters on human body, Safety measures for electric shock, overhead and other protections, portable electrical apparatus, Electric work in hazardous atmosphere, Energy conservation and safety

Precautions and safety measures in substation

(11+4 Hours)

UNIT-III**Characteristics of Energy audit & Management**

Elements of energy audits, energy use profiles, measurements in energy audits, presentation of energy audit results, case study, Electrical system optimization

Demand side management (DSM)-techniques of DSM, peak clipping, peak shifting, valley filling, types of tariffs.

Energy efficient equipment

(12+3 Hours)

Unit IV**Introduction to Energy Audit**

Introduction Energy situation – world and India, energy consumption, conservation-need in thermal utility, Codes, standards and Legislation, Energy economic analysis-the time value of money concept, developing cash flow models, payback analysis, depreciation, taxes and tax credit.

Energy Policy based on management

(11+4 Hours)

(Total: 45+15=60 Hours)

Textbook (s)

1. J.B Gupta, "A Course in Electrical Installation, Estimating and Costing", S.K Kataria & Sons, 2nd Edition, 2013.
2. Albert Thumann, "Fundamentals of Energy Engineering", Prentice Hall Inc, Englewood Cliffs, New Jersey, 3rd Edition, 2013.
3. Dr. K U Mistry, "Fundamentals of Industrial Safety and Health", Siddharth Prakashan, 1st Edition, 2008

Reference (s)

1. Surjeet Singh, "Estimating and Costing", Dhanpat Rai & Co., 2nd Edition, 2003.
2. D.P.Sen, K.R.Padiyar, Indrane Sen and M.A.Pai, "Recent Advances in Control and Management of Energy Systems", Interline Publisher, 1st Edition, 2013
3. Rao, S. and Saluja, H.L., "Electrical Safety, Fire Safety Engineering and Safety Management, Khanna Publishers, 1988.
4. Albert Thumann and Willium. J. Younger, "Handbook of Energy Audits, River Publishers, 9th Edition, 2012.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	25	25	---
Understand	25	75	---
Apply	50	---	50
Analyze	---	---	50
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

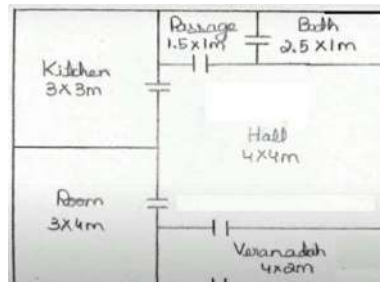
1. Define estimation and state its purpose.
2. Define power wiring.
3. Define principle of energy audit
4. Define energy management and auditing
5. Name the factors on which the fusing current depends.

Understand

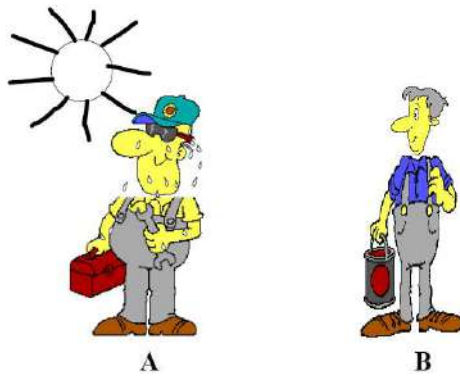
1. Interpret the size of conduit for different ratings of motors
2. Classify various types of domestic wiring and suggest their suitability for respective installation.
3. Explain the types of energy audit
4. Explain about depreciation with all methods
5. Summarize the duties of energy auditor and manager
6. Illustrate Load management
7. Formulate energy auditing report in tabular form

Apply

1. Draw the electrical circuit and develop the quantity of materials required for conduit wiring used in a house, the plan of which is shown in Figure 1. Assume the height of the ceiling is 3.6m and one plug point is to be provided in each room.



2. Develop a neat diagram showing the position of switch boards, distribution boards and accessories for a hall of 15m*5m*4.5m height. The hall is to be fitted with fan and light points. Make your own assumptions for the number of light and fan points and other missing data.
3. (i) Why might Worker A be injured more than Worker B if they were both shocked by the same amount of electrical current?



- (ii) How do electrical fires start and how can they be prevented?
 (iii) How does electrical shock occur and how can it be prevented?
 (iv) What are electrical safety risks in a lab?

(For Open Book Examination and not for semester end examination)

Analyze

1. Analyze how the ratings of cables and fuse wires for wiring a motor installation are determined.
2. Survey different types of domestic wiring systems.
3. Classify different types of industrial wiring systems.
4. Discover the significance of earthing systems in distribution systems.
5. Design the main control panel for a small workshop for control of three phase motors. The main distribution panel should be provided with TP MCB of 63 ampere rating, TP, MCB's for control of three phase motors, three bus bars and one ELCB. The supply to the power system should commence through 3-phase energy meter and an alternate source of supply from diesel generator set. Both supplies should be controlled through their respective main switches (filled with built in HRC fuses. The triple pole change over switch should be installed to ensure continues power supply to the motors. Show power connections to at least one motor starter TP. MCB and ELCB to be installed close to the motor. The equipment should be installed on the motor control panel close to the motor.

(For Open Book Examination and not for semester end examination)

Course Outcome(s)

1. Explain the need of optimization of engineering systems.
2. Apply classical optimization techniques, linear programming, transportation problem.
3. Explain the fundamental knowledge of dynamic programming problems.
4. Use classical optimization techniques and numerical methods of optimization.
5. Solve the problems of project management using CPM and PERT.
6. Solve Non-linear programming problems of some kinds.

CO-PO Mapping

COs	PO ₁	PO ₂	PO ₃	PO ₅
1	3	2	2	1
2	3	2	2	2
3	2	2	2	1
4	2	2	2	2
5	2	2	3	1
6	2	2	2	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit- I

Introduction and Classical optimization Techniques:

Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems. Classical Optimization Techniques: Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable Optimization with equality constraints. Solution by method of Lagrange multipliers – Multivariable Optimization with inequality constraints – Kuhn – Tucker conditions.

11+4 hours

Unit- II

Linear Programming Problem: Standard form of a linear programming problem – geometry of linear programming problems – definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation to the simplex method – simplex algorithm.

Transportation Problem: Finding initial basic feasible solution by north – west corner rule, least cost method and Vogel’s approximation method – testing for optimality of balanced transportation problems.

11+4 hours

Unit- III

Dynamic Programming (D.P): Multistage decision processes. Concepts of sub optimization, Recursive Relation-calculus method, tabular method, LP as a case of D.P.

Classical Optimization Techniques: Single variable optimization without constraints, Multi variable optimization without constraints, multivariable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions.

Numerical Methods For Optimization: Nelder Mead’s Simplex search method, Gradient of a function, Steepest descent method, Newton’s method.

11+4 hours

Unit- IV

CPM and PERT: Drawing of networks, Removal of redundancy, Network computations, Free slack, Total slack, Crashing, Resource allocation.

Non-Linear Programming: Characteristics, Concepts of convexity, maxima and minima of functions of n-variables using Lagrange multipliers and Kuhn-Tucker conditions, One dimensional search methods, Fibonacci, golden section method and gradient methods for unconstrained problems.

12+3 hours

Total: 45+15 hours

Textbook(s)

1. Operations Research: An Introduction, Prentice Hall of India (2007) 8th ed.
2. Kasana, H.S., Introductory Operation Research: Theory and Applications, Springer Verlag (2005).
3. Rardin, Ronald L., Optimization in Operations research, Pearson Education (2005). Ravindran A, Phillips D.T. and Solberg J.J.
4. Operation Research: Principles and Practice, John Wiley (2007).
5. Engineering Optimization Theory and Practice, S.S.Rao, New Age International (P) Ltd, Publishers
6. Kalyanmoy Deb Multi-objective optimization using evolutionary algorithms John Wiley Publications
7. Jasbir S. Arora Introduction to Optimum Design McGraw Hill Publication
8. Optimization for Engineering Design by Kalyanmoy Deb, PHI Publishers
9. Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers
10. Operations Research by Hillar and Liberman, TMH Publishers

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination
Remember	10	10	-
Understand	10	10	-
Apply	80	80	50
Analyze	-	-	40
Evaluate	-	-	10
Create	-	-	-
Total (%)	100	100	100

Remember

1. What are the types of classical optimization techniques?
2. What are the draw backs of classical optimization techniques?
3. State the assumptions of cpm and pert.
4. Discuss simplex algorithm of LPP.

Understand

1. What are the limitations of PERT and CPM?
2. How non-linear programming problems are different from linear programming problems ?
3. What kind of problems can be solved through dynamic programming technique?

Apply

1. By using simplex method, minimize $Z = 2X_1 + 9X_2 + X_3$ Subjected to the constraints: $X_1 + 4X_2 + 2X_3 \geq 5$, $3X_1 + X_2 + 2X_3 \geq 48$, $X_1 \geq 0$, $X_2 \geq 0$, $X_3 \geq 0$.
2. Find the optimal solution to the following transportation problem for which the cost, origin-availabilities and destination-requirements are as given below

	A	B	C	D	
I	1	2	-2	3	70
II	2	4	0	1	38
III	1	2	-2	5	32
	40	28	30	32	

3. A college student has 7 days remaining before final examinations begin in her four courses, and she wants to allocate this study time as effectively as possible. She needs at least 1 day on each course, and she likes to concentrate on just one course each day, so she wants to allocate 1, 2, 3, or 4 days to each course. Having recently taken an OR course, she decides to use dynamic programming to make these allocations to maximize the total grade points to be obtained from the four courses. She estimates that the alternative allocations for each course would yield the number of grade points shown in the following table:

Study Days	Estimated Grade Points			
	Course			
	1	2	3	4
1	3	5	2	6
2	5	5	4	7
3	6	6	7	9
4	7	9	8	9

Solve this problem by dynamic programming.

Course Outcomes

1. Summarize sensor characteristics and applications
2. Demonstrate acceleration, shock and vibration sensors
3. Demonstrate position and weight sensors
4. Demonstrate sound, ultrasound and infrared sensors
5. Outline the working principle of bio sensors
6. Exemplify the applications of chemical sensors

COs-POs Mapping

COs	PO ₁
1	2
2	3
3	3
4	3
5	3
6	2

3-Strongly linked | 2-Moderately linked| 1-Weakly linked

Unit I**Sensor Fundamentals and applications**

Sensor Characteristics, System Characteristics, Instrument Selection, Data Acquisition and Readout, Installation, Acceleration, Shock and Vibration Sensors: Technology Fundamentals, Selecting and Specifying Accelerometers, Applicable Standards, Interfacing and Designs

Sensor limitations, measurement issues and criteria

16 Hours

Unit II**Position and weight sensors**

Position, direction, distance measurement-large scale, distance travelled, and rotation. Force, Load and Weight Sensors : Quartz Sensors-Charge Mode High-Impedance Piezoelectric Force Sensor, Voltage Mode Low-Impedance Piezoelectric Force Sensor, Piezoelectric Force Sensor Construction, types of Strain Gage Sensors

Special applications of strain gage sensors, gravitational sensing

16 Hours

Unit III**Sound, Ultrasound and Infrasound sensors**

Principles, Audio to electrical sensors and transducers: moving iron microphone, moving coil microphone, capacitor microphones. Microphone problems, frequency and wavelengths. Electrical to audio transducers: moving iron transducer, moving coil transducer, Capacitor transducers. Ultrasonic transducers, Infrasound sensors.

Building acoustics, Microphone Standards

15Hours

Unit IV**Biosensors and Chemical Sensors**

Introduction to Biosensors, Applications of Biosensors, Origin of Biosensors, Bioreceptor Molecules, Transduction Mechanisms in Biosensors, Application Range of Biosensors, Technology Fundamentals of chemical sensors, chemical sensing techniques and applications.

Evolution of Biosensors, smoke sensors

13 Hours

Total: 60 Hours

Textbook (s)

1. Jon Wilson ,Sensor Technology Hand Book, Newnes 2004.
2. Ian.R.Sinclair,Sensors and Transducers, third edition, Newnes publications
3. Patranabis D. ,Principles of Industrial Instrumentation,TMH. 2nd edition

Reference (s)

1. Patranabis D, Sensors and Transducers, 2nd Edition, PHI, New Delhi, 2010
2. E. O. Doebelin ,Measurement system: Applications and Design, fourth edition,McGraw Hill Publications.

SAMPLE QUESTION (S)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	20	20	--
Understand	50	40	--
Apply	30	40	60
Analyze	-		40
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. Define sensors
2. List types of microphones
3. Define bioreceptor molecules.
4. List types of strain gages

Understand

1. Represent acceleration sensors
2. Illustrate Charge Mode High-Impedance Piezoelectric Force Sensor.
3. Identify Transduction Mechanisms in Biosensors.

Apply

1. Demonstrate electrical to audio transducers.
2. Demonstrate Transduction Mechanisms in Biosensors.
3. Demonstrate gas chromatograph.
4. Find a suitable sensor for the treatment of insulin-dependent diabetes with open loop approach that is portable and requires minimal operational skill. **(For Open Book Examination and not for semester end examination).**
5. Water's conductivity varies by several orders of magnitude as it varies from ultrapure to ordinary tap water. Carry-out the use of a simple inexpensive sensor to measure water impurities. **(For Open Book Examination and not for semester end examination)**

Analyse

1. Compare capacitor microphones and capacitor transducers. **(For Open Book Examination and not for semester end examination)**
2. Outline the process of using stars for finding the position. **(For Open Book Examination and not for semester end examination)**

Course Outcomes

1. Summarize the fundamental concepts of Artificial Intelligence.
2. Illustrate the Concepts of Heuristic Search Techniques.
3. Demonstrate working knowledge of reasoning in the presence of incomplete and/or uncertain information
4. Make use of concept of Game Playing Algorithms.
5. Outline the concept of Planning System
6. Explain the Natural language processing system

CO-PO Mapping

CO	PO ₁	PO ₂	PO ₃
1	2	1	2
2	2	2	3
3	3	1	1
4	1	2	2
5	1	3	2
6	1	2	2

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I**Introduction**

Definition, AI problems, AI techniques, Defining problem as a state space search, Production Systems-Control Strategies, Problem characteristics, Production system characteristics. Problems – tic-tac-toe, 8-puzzle problem, Chess problem, Water Jug Problem, Missionaries and cannibals' problem, Monkey and banana problem.

Application of AI-Tower of Hanoi problem- Travelling Salesman Problem

12+3 Hours

Unit II**Heuristic Search Techniques**

Generate-and-test, Hill climbing, Best-first-search – OR Graphs – A* Algorithm, Problem reduction – AND-OR Graphs – AO* Algorithm, constraint satisfaction - cryptarithmic problem.

Depth-first search – Breadth-first search- Data abstraction

11+4 Hours

Unit III**Knowledge representation**

Knowledge Representation Issues, Representation and mapping, Approaches to Knowledge Representation, Frame Problem, Propositional logic, Predicate logic, Resolution, weak slot and filler structure-semantic nets.

Filler structures-conceptual dependency-scripts

11+4 Hours

Unit IV**Game Playing and Planning**

Mini-max search, Alpha-beta cutoffs, planning system, Block world problem, goal stack planning, hierarchical planning, Natural language processing, syntactic processing, Decision trees, Perception, Vision, Speech recognition.

Learning - Navigation – Manipulation - Robot Architecture

11+4 Hours

Total: 45+15 Hours

Textbook (s)

1. E. Rich K.Knight, and B. Nair, Artificial Intelligence, 3rdEdition, TMH, 1 July 2017
2. Russel Norvig, Artificial Intelligence A modern Approach, 3rd Edition, Pearson Education, 2010.

Reference (s)

1. Patrick Henry Winston, Artificial Intelligence, third edition, Pearson Education Asia, 2005
2. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, 2nd Edition, PHI, 2009

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	40	40	--
Understand	30	40	--
Apply	30	20	70
Analyze	--	--	30
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

SAMPLE QUESTION (S)

Remember

1. State the tasks, which are associated with A.I.
2. Give an example of crypt-arithmetic problem.
3. Define Speech Recognition.
4. Recall Intelligence

Understand

1. Explain Turing Test.
2. Explain the characteristics of production system.
3. Write A* algorithm in detail and explain its functionality to solve 8-puzzle problem.
4. Explain the semantic analysis phase done through case grammars in Natural Language understanding

Apply

1. Distinguish between weak and strong slot filler structures
2. Discuss the tic-tac-toe problem in detail and explain how it can be solved using AI technique
3. Construct semantic net representation for the following:
 - (i) Pompeian (Marcus), Blacksmith (Marcus)
 - (ii) Mary gave the green flowered vase to her favorite cousin.

Analyze

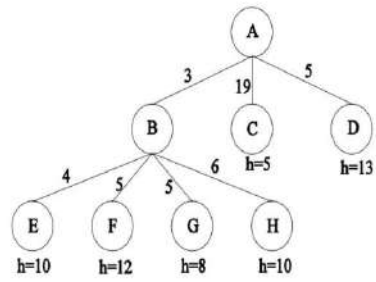
1. Show that the tower of Hanoi problem can be classified under the area of AI. Give a state space representation of the problem.
2. Give an example of a problem for which breadth-first search would work better than depth-first search. Justify your answer.
3. Consider the following sentences:

John likes all kinds of food.
Apples are food.
Chicken is food
Anything anyone eats and isn't killed by food.
Bill eats peanuts and is still alive.
Sue eats everything Bill eats.

 - (a) Translate these sentences into formula in predicate logic.
 - (b) Convert the formulas of part a into clause form.

Prove that John likes peanuts using resolution.

4. Consider the following search tree produced after expanding node A, where each arc is labeled and the leaves are labeled with the value of a heuristic function, h. **(For Open Book Examination and not for semester end examination).**



- (i) Identify the node, which is expanded next by each of the following search methods?
- Breadth First Search
 - Depth-First Search
 - Best-First Search
 - A* Search
 - AO* Search
- (ii) Construct the Min Max Tree for the above figure (ignoring the cost values)
- (iii) Identify whether the tree is eligible for pruning or not, if it is yes trace the alpha beta prunes.

Course Outcomes

1. Outline the need of energy storage systems
2. Identify new technologies for energy storage and conversion systems
3. Select and defend appropriate fuel cell technology for a given application
4. Summarize the different types of fuel cells and batteries
5. Analyse the performance of specific battery and fuel cell systems
6. Design and develop suitable hydrogen storage system to be used along with fuel cell system

COs - POs Mapping

COs	PO ₁	PO ₃	PO ₆	PO ₇
1	3	--	2	3
2	3	3	2	3
3	2	1	2	3
4	2	3	2	3
5	3	1	2	3
6	3	1	2	3

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I**Introduction to Energy Conversion and Storage Systems**

Classification of Energy Sources, Principle fuels for energy conversion, Necessity of energy storage, different types of energy storage, mechanical, chemical, electrical, electrochemical, biological, magnetic, electromagnetic, thermal, comparison of energy storage technologies

Fuel cells- Batteries- Super capacitors

12+3 Hours

Unit II**Energy Conversion Systems**

Fuel cells: Introduction and overview, operating principle, polarization curves, components, types of fuel cell, low and high temperature fuel cells, fuel cell stacks. Fuel cell characterization and analysis of polarization curve and calculate kinetic, ohmic, and transport losses; estimate internal resistance and hydrogen cross-over of the fuel cell

Faraday's law, Open circuit voltage, ohmic resistance, limiting current

11+4 Hours

Unit III**Energy Storage Devices**

Fundamentals and technologies, characteristics and performance comparison: Lead-acid, Nickel-Metal hydride, Lithium Ion; Battery system model, emerging trends in batteries.

Hybrid systems for energy storage

12+4 Hours

Unit IV**Design and Applications of Energy Storage**

Renewable energy storage-Battery sizing and stand-alone applications, stationary (Power Grid application), Small scale application-Portable storage systems and medical devices, Mobile storage Applications- Electric vehicles (EVs), types of EVs, batteries and fuel cells, future technologies, hybrid systems for energy storage

Nernst equation- Butler-Volmer theory- Gibbs free energy

11+3 Hours

Total: 45+15 Hours

Textbook(s)

1. O' Hayre R. P., Cha S. W., Colella W., and Prinz F. B., Fuel cell fundamentals, John Wiley, 2008
2. Larminie J., Dicks A. and McDonald M. S., Fuel cell systems explained. Vol. 2, Wiley, 2003
3. Bailie, Richard C, Energy conversion engineering, Wesley, 1978

Reference (s)

1. Vielstich W., Lamm A., and Gasteiger H. A, Handbook of Fuel Cells: Fundamentals, Technology, Applications, Vol (1-4), Wiley, 2003
2. Gupta R. B, Hydrogen Fuel: Production, Transport and Storage, CRC Press, 2008

- Bard A. J., Faulkner L. R., Leddy J., and Zoski, C. G, Electrochemical methods: fundamentals and applications (Vol. 2), Wiley, 1980

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	20	20	--
Understand	30	30	40
Apply	50	50	60
Analyze	--	--	--
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Sample Question (s)

Remember

- List any two types of fuel cells and their uses.
- What is open circuit voltage?
- Define limiting current.
- Define glass transition temperature.

Understand

- Distinguish high temperature fuel cells and low temperature fuel cells.
- Explain in detail the principle and mechanism of lithium ion battery.
- Explain about fuel cell characterization.
- Discuss about portable energy storage systems.

Apply

- A company is developing a new car powered by a fuel cell system that runs on H₂. You have been asked to consider generating the H₂ by electrolysis with a fuel cell. The H₂ tank to be used is 10 liters in volume and a fill-up requires a pressure of 34 atm.
- Consider the following specifications of the system, 60% conversion of H₂O $E_0 = 1.172$ V The cathode pressure is maintained at 1 atm. The anode pressure is maintained at 1 atm Membrane thickness = 100 μm Membrane conductivity (σ) = 0.1 S/cm ($S = 1/\Omega$) Electrolysis T = 373 K (assume water is in the gas phase) H₂ storage tank T = 298 K
 - Calculate the current required to operate at a voltage of 1.8V.
 - Calculate the rate of hydrogen production per membrane area and the total membrane area required to fill the tank in 2 minutes.
 - How the fuel cell car is more viable than a diesel or petrol car. Justify?
- The polarization curve for the fuel cell consists of 3 different losses such as ohmic, activation and mass transport in these 3 losses what is predominant loss, explain various precautions/ designs can overcome these losses. **(For Open Book Examination and not for semester end examination).**
- Describe the selection criterion for choosing the specific fuel cell among the alternatives present in the market, for household application what fuel cell you suggest? Justify your answer. **(For Open Book Examination and not for semester end examination).**

Course Outcomes

At the end of the course, students will be able to

1. Understand key concepts in multimedia technology.
2. Identify basic multimedia types and data representations.
3. Describe transmission of audio and video.
4. Explain multimedia data compression techniques.
5. Identify various video and audio compression techniques.
6. Demonstrate technical knowledge and limited proficiency in designing production elements.

CO - PO Mapping

COs	PO ₃	PO ₅	PO ₇
1	3	3	2
2	3	3	1
3	3	3	2
4	2	3	2
5	3	3	1
6	2	3	3

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Syllabus**Unit I****Introduction to multimedia**

What is multimedia?, Multimedia and Hypermedia, World Wide Web, Overview of Multimedia Software Tools, Graphics and Image Data Representations: Graphics/Image Data Types, Color in Image and Video: Color Science, Color Models in Images, Color Models in Video.

Popular file formats.

13+3 Hours

Unit II**Fundamental Concepts in Video and Digital Audio**

Types of Video Signals, Analog Video, Digital Video, Digitization of Sound, MIDI, Quantization and Transmission of Audio.

DPCM, DM, ADPCM

10+5 Hours

Unit III**Multimedia Data Compression**

Lossless compression algorithms: Run-Length Coding, Variable Length Coding, and Dictionary Based Coding. Lossy compression algorithms: Quantization, Transform Coding, Wavelet-Based Coding

Arithmetic Coding, Lossless Image Compression

12+4 Hours

Unit IV**Basics of Video and Audio Compression**

Introduction to Video Compression, Video Compression based on Motion Compensation, Search for Motion Vectors, Video Coding Overview of MPEG-1, MPEG-2, MPEG-4

ADPCM in Speech Coding, MPEG Audio Compression.

MPEG-7, Basics of Computer and Multimedia networks

10+3 Hours

Total: 60 Hours

Textbook (s)

1. Ze-Nian Li and Mark S.Drew, "Fundamentals of Multimedia", 1st Edition, PHI/Pearson Education, 2009.
2. Weixel, "Multimedia Basics", 2nd Edition, Thomson Press, 2006.

Reference (s)

1. Nigel Chapman and Jenny Chapman, "Digital Multimedia", 3rd Edition, Wiley Dreamtech, 2009.
2. Steve Heath, "Multimedia and Communications Technology", 2nd Edition, Elsevier (Focal Press), 1999.
3. Steinmetz, Ralf, Nahrstedt, "Multimedia Applications", 1st Edition, Springer, 2004.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	20	10	--
Understand	30	30	--
Apply	40	50	40
Analyze	10	10	30
Evaluate	--	--	30
Create	--	--	--
Total (%)	100	100	100

Sample Question (S)**Remember**

1. Define multimedia
2. List some multimedia software.
3. List some multimedia hardware

Understand

1. Explain the application of multimedia in education and e-commerce
2. Explain analog and digital video in details
3. Explain the need of multimedia and write down its applications
4. Illustrate the scope of multimedia in e-governance

Apply

1. Identify the applications of multimedia in entertainment industry
2. Identify three novel applications of the Internet or multimedia applications. Discuss why you think these are novel

Analyze

1. Compare plain text and formatted text.
2. Analyze various video compression techniques
3. Analyze various audio compression techniques

Evaluate

1. If a set of ear protectors reduces the noise level by 30dB, how much do they reduce the intensity (the power)?
2. My old SoundBlaster card is an 8-bit card.
 - a. What is it 8 bits of?
 - b. What is the best SQNR it can achieve?
5. Implement Huffman coding, adaptive Huffman coding, arithmetic coding and LZW coding algorithms using your favorite programming language. Generate at least three types of statistically different artificial data sources to test your implementation of these algorithms. Compare and comment on each algorithm's performance in terms of compression ratio for each type of data source. **(For Open Book Examination and not for semester end examination).**
6. Assume we have an unbounded source we wish to quantize using an M-bit mid tread uniform quantizer. Derive an expression for the total distortion if the step size. **(For Open Book Examination and not for semester end examination).**

Course Outcomes

1. Explain the properties of nano-materials and their applications in relation to bulk materials
2. Describe the nano size effect on optical, electrical, magnetic and thermal properties
3. Apply various chemical and physical methods for the synthesis of nanomaterials
4. Characterize nano materials by powder XRD and microscopy techniques.
5. Illustrate the structure, properties and applications of Fullerenes and Carbon nanotubes.
6. Review the applications of nanomaterials, specially semiconducting metal oxides for sensing and catalysis

COs – POs Mapping

COs	PO ₁	PO ₁₂
1	3	1
2	3	1
3	3	1
4	3	1
5	3	1
6	3	1

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I**Introduction to Nanomaterials**

Introduction to nanomaterials and nanotechnology, Nano-sizes and their unique properties: comparison with the bulk materials, Different shapes sizes and morphology of nanomaterial; Defects in Nano crystalline materials, Effect of grain size on physical properties – magnetic, electrical, optical, thermal and mechanical properties.

Graphite to graphene – effect on properties

11+3 Hours

Unit II**Synthesis Techniques of Nanomaterials**

Top Down Approaches: Grinding, Planetary milling and comparison of particles; Bottom Up Approach: Wet Chemical Synthesis - Microemulsion Approach, Colloidal Nanoparticles Production, Co-precipitation, Sol Gel Method, Hydrothermal method, Sonochemical Approach,; Gas phase Production Methods - Chemical Vapour Deposition; Carbon Nano structures: carbon clusters, carbon nano tubes, graphene- synthesis, formation.

Microwave synthesis and Atomization

12+4 Hours

Unit III**Characterization of Nanomaterials**

Fractionation principles of particle size measurements, Particle size and its distribution, distinguishing the nano size from bulk by powder X-ray Diffraction patterns; Optical transitions in solids, photonic crystals, Microscopy techniques: Scanning Electron Microscopy, EDAX, Atomic Force Microscopy, Scanning Tunneling Microscopy, and Transmission Electron Microscopy

Zeta potential, density of states

11+4 Hours

Unit IV**Applications of Nanomaterials**

Self-assembly and molecular manufacturing; Surfactant based system & Colloidal system – Applications; Functional materials - Nano coatings, GaN wires, quantum dots, Nano crystalline TiO₂ and ZnO; Applications of single & multi walled CNTs

Nano sensors - based on optical properties

11+4 Hours

Total: 45+15 Hours

Textbook (s)

1. B. S. Murthy, P. Shankar, Baldev Raj, B.B. Rath, Ames Murday, Text book of Nanoscience and Nanotechnology, Springer & Universities Press (India) Pvt. Ltd., 2013.
2. S. K. Kulkarni, Nanotechnology: Principles & Practices, 3rd Ed, Springer, 2015

Reference (s)

1. S. M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009
2. R. Kelsall, I. Hamley, M. Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005
3. G. L. Hornyak, H.F. Tibbals, J. Dutta, J. J. Moore, Introduction to Nanoscience and Nanotechnology CRC Press, 2008

- J. H. Davies, The Physics of Low Dimensional Semiconductors: An Introduction, Cambridge University Press, 1998

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	20	20	-
Understand	60	60	-
Apply	20	20	60
Analyze	-	-	40
Evaluate	--	-	-
Create	--	-	-
Total (%)	100	100	100

Sample question (s)

Remember

- Define Nano structured material.
- List any four applications of nanotechnology.
- State Moore's first law and second law.

Understand

- What is the difference between Nano science and nanotechnology?
- Describe elastic scattering and inelastic scattering of electrons
- Explain the sol-gel method of synthesis of Nano powders

Apply

- Explain the principle behind protection of skin from UV radiation by sun screen lotion
- Show that the surface area to volume ratio increases drastically as particle size comes down from micro to Nano size.
- Assess the variation of thermal and optical properties of nanomaterial with that of the bulk
- Show how the shape and size can be controlled in the formation of nanostructures using surfactants
- Nano materials are increasingly being used in various applications. Answer the following questions regarding Nano materials and technologies:
 - Classify the Nano materials based on the dimensionality and represent with examples.
 - Construct the block diagram of chemical vapour deposition (CVD) method and explain the process of synthesis of nanomaterials using CVD.
 - Model the Electronic band structure and explain photonic crystals.
 - Select any four applications of GaN nanowires and assess their impact on daily life.

(For Open Book Examination and not for semester end examination)

Analyze

- Compare the bottom up & top down approaches in nanotechnology
- Outline how powder XRD technique can be used for characterization of a nano material
- Electrical and magnetic properties vary for nano material compared to bulk material. Justify
- Distinguish between single walled carbon nano tubes and multi walled carbon nano tubes.
- Nano materials are increasingly being used in various applications. Answer the following questions regarding Nano materials and technologies:
 - Show the various types of defects in nanocrystalline materials and attribute their effect on properties.
 - Schematically illustrate the sol-gel method of preparation of nanomaterials and assess its advantages/disadvantages with other methods.
 - Propose various characterization methods of nanomaterials and explain the merits/demerits of using powder X-ray diffraction method.
 - Assess any four applications of nanocrystalline TiO₂ in detail.

(For Open Book Examination and not for semester end examination)

21DS001 Fundamentals of Data Science

Course Outcomes

1. Understand the key steps and pipeline of Data Science and its application in solving real-world problems.
2. Recognize the importance of measuring similarity and dissimilarity between features in data for various analysis tasks.
3. Appreciate the significance of pre-processing techniques in preparing data for analysis in real-time scenarios.
4. Identify the characteristics and practical applications of different regression models used in real-world scenarios.
5. Evaluate classification models using appropriate metrics, including the confusion matrix, to assess model performance and make informed decisions.
6. Understand the principles of ensemble modeling and clustering, and apply appropriate ensemble techniques to improve the accuracy and reliability of machine learning models.

COs-POs Mapping

COs	PO3	PSO1	PSO2
1	2	2	2
2	2	3	3
3	2	3	3
4	2	2	2
5	2	2	2
6	2	2	2

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

UNIT-I

12+8 hours

Introduction: Relation among AI, ML and Data Science, Importance of Data Science; Data Science Process;

Data Exploration: Objectives of Data Exploration, Forms of Data (Structured, Semi Structured, Unstructured), Datasets (data objects and types of attributes/fields), Characteristics of Datasets and corresponding Statistical Measures;

Data Visualization: Univariate Visualization, Multivariate Visualization.

Categorization of Data Science Algorithms. Overview of different kind of dataset (i.e. text, image) and the different format (ie. CSV, json).

Practical Components

1. Perform data exploration and statistical analysis on a real-world dataset to understand its characteristics and calculate relevant statistical measures.
2. Explore datasets of different formats (text and image) and apply data exploration techniques accordingly.
3. Visualize a dataset using univariate and multivariate visualization techniques to analyze the distribution of data and explore relationships between variables.
4. Analyze a dataset using categorical data visualization techniques (bar plots, pie charts) to gain insights into demographic patterns and distributions.

UNIT-II

12+8 hours

Data Similarity/Dissimilarity: Understanding data similarity and dissimilarity, Measures for comparing different types of data (nominal, ordinal, binary, numerical).

Data Preprocessing: Data Preprocessing Pipeline, Preprocessing techniques for cleaning and integrating data, Data reduction techniques for handling large datasets, Cosine Similarity.

Distance based similarity (Euclidean distance, Jaccard Similarity).

Practical Components

1. Apply data preprocessing techniques and impute missing values on a real-world dataset.
2. Select a large dataset and apply data reduction techniques such as feature selection and

dimensionality reduction (e.g., PCA, t-SNE) to handle its size while preserving important information and patterns in the data.

3. Calculate the cosine similarity between pairs of text documents to measure their similarity.
4. Integrate multiple datasets and perform data cleaning to create a unified and consistent dataset.

UNIT-III

12+8 hours

Regression : Introduction to linear regression for forecasting numerical quantities, Logistic regression for classification problems, Regularization techniques for improving model performance;

Classification: Classification Principles, Classification Model Evaluation Metrics (Confusion Matrix), Classification using Decision Trees, Distance based Classifier (k-NN), Bayesian classifier.

Regression vs classification.

Practical Components

1. Perform linear regression on a dataset to forecast a specific target variable. Evaluate the performance of the regression model using appropriate evaluation metrics.
2. Apply the Decision Trees algorithm to build a classification model. Utilize appropriate evaluation metrics and construct a confusion matrix to assess the model's performance.
3. Perform linear regression on a dataset and apply regularization techniques such as L1 or L2 regularization to improve the model's performance.
4. Implement a Bayesian classifier to classify emails as spam or non-spam. Use appropriate evaluation metrics to assess the classifier's performance.

UNIT-IV

12+8 hours

Ensemble Learning: Conditions for Ensemble Modeling, Overview of ensemble techniques (Voting, Bagging, Boosting and Random Forest);

Clustering: Clustering Principles, Clustering for description/preprocessing/classification, Types of Clustering, Clustering Evaluation Parameters, Clustering Algorithms (k-Means) and Evaluation metrics for assessing the quality of clustering results;

Applications/Purpose of Clustering.

Practical Components

1. Explore ensemble learning techniques such as Random Forest on a dataset suitable for classification or regression.
2. Apply the K-means clustering algorithm on a dataset for classification purposes. Use evaluation metrics to assess the quality of the clustering results and experiment with different values of k.
3. Use a voting classifier to combine multiple classification algorithms and improve the accuracy of the final model.
4. Perform Hyperparameter tuning for any Ensemble Algorithms (ie. RF)

Total: 48+32 Hours

Textbooks:

1. Vijay Kotu & Bala Deshpande, "Data Science: Concepts and Practice", 2nd Edition, Morgan Kaufmann Publication, 2017.
2. Jiawei Han & Micheline Kamber, "Data Mining: Concepts and Techniques", 3rd Edition, Morgan Kaufmann Publishers, 2012.
3. Pang-Ning Tan et al., "Introduction to Data Mining", 2nd Edition, Pearson Publications, 2019.

References:

1. Vijay Kotu & Bala Deshpande, "Data Science: Concepts and Practice", 2nd Edition, Morgan Kaufmann Publication, 2017.
2. Tom M. Mitchell, "Machine Learning", Tata McGraw Hill, 1997.
3. Sunil Gollapudi, "Practical Machine Learning" First Edition 2016, Packt Publishing Ltd.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Openbook Test 1 (%)
-----------------	-----------------	-----------------	---------------------

Remember	20	20	--
Understand	50	30	--
Apply	30	30	80
Analyze	--	20	20
Evaluate	--	--	--
Create	--	--	--
Total(%)	100	100	100

SAMPLEQUESTION(S)

Remember

1. What are the different forms of data in data science? Provide examples for each form.
2. Name the statistical measures used to analyze datasets in data science.

Understand

1. Why is pre-processing important in machine learning? Explain with relevant examples

What is the difference between supervised and unsupervised algorithms? Provide an example for each type.

Apply.

1. Imagine you have a dataset containing information about houses. How would you handle the following scenarios using pre-processing techniques:
 - a. Data Cleaning: How would you deal with missing values in the dataset? What approach would you take to handle outliers or inconsistent data?
 - b. Data Integration: Suppose you have additional datasets with relevant information about houses, such as neighborhood demographics or school ratings. How would you combine this information with the existing dataset?
 - c. Data Reduction: The dataset contains numerous features. How would you simplify the dataset by reducing the number of features without losing important information?
 - d. Data Transformation and Discretization: How would you standardize numerical features in the dataset? Additionally, how would you convert continuous variables, such as house prices, into categorical variables for analysis purposes?

Open Book Question(s)

1. Discuss the importance of data visualization in data science. Provide examples of univariate and multivariate visualizations, and explain how they can be used to gain insights from complex datasets. Support your answer with relevant illustrations or diagrams.
2. Compare and contrast supervised and unsupervised learning algorithms. Provide a detailed explanation of each type, including their characteristics, applications, and differences in the training process. Give an example scenario where you would use each type of algorithm.
3. Assume you have been given a dataset with various features related to customer demographics and their purchasing behavior. Design a data science pipeline to address the following tasks:
 - a. Data exploration and statistical analysis of the dataset.
 - b. Preprocessing steps, including handling missing values, data cleaning, and feature transformation.
 - c. Applying a suitable regression model to predict customer spending based on the available features.
 - d. Evaluating the performance of the regression model using appropriate evaluation metrics.

Course Outcome

1. Understand basic aspects on air pollution and the quality of atmospheric environment
2. Evaluate different types of air pollution and the means of abatement control
3. Identify the sources for noise pollution and control methods
4. Understand the different steps within environmental impact assessment
5. Compare both orally and in written form the key aspects of environmental impact assessment
6. Analyze different case studies/examples of EIA in practice

COs-POs Mapping

COs	PO6	PO7	PO12
1	1	2	1
2	1	2	1
3	1	2	1
4	2	1	1
5	2	1	1
6	2	1	1

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I**Sources and Effects of Air Pollution**

Classification of Air pollutants, Particulates and gaseous pollutants, effects of air pollution on human being, materials, animals and vegetation; global warming- ozone layer depletion, sampling and analysis, basic principle of sampling, source of ambient sampling, analysis of pollutants, principles
Sampling of air Pollutants; Ambient air quality standards.

12 Hours**Unit II****Air Pollution Control and Noise Pollution**

Air Pollution Control: Particulate control by gravitational, centrifugal, filtration, scrubbing, electrostatic precipitation- selection criteria for equipment- gaseous pollutant control by adsorption, absorption, condensation, combustion.

Noise Pollution: Sources, Effects, Assessments, Standards and Control Methods, Prevention Methods.
Plume rise behavior ;Measurement of Noise level.

12 Hours**Unit III****Environmental Impact Assessment**

Impacts of Development on Environment, Environmental Impact Assessment (EIA): Objectives, Historical development, EIA Types, EIA Notification and Legal Framework, Stakeholders and their Role in EIA.

Screening and Scoping in EIA: Drafting of Terms of Reference, Baseline monitoring, Prediction and Assessment of Impact on land, water, air, noise and energy, flora and fauna EIA Methods- Matrices – Networks – Checklist Methods.

Rio Principles of Sustainable Development; Mathematical models for Impact prediction.

12 Hours**Unit IV****Environmental Management Plan**

Plan for mitigation of adverse impact on water, air and land, water, energy, flora and fauna, Environmental Monitoring Plan, EIA Report Preparation, Review of EIA Reports, and Environmental Clearance.

Case Studies: EIA case studies pertaining to Infrastructure Projects, Roads and Bridges, Ports and Harbor, Airports, Dams and Irrigation projects, Power plants, CETPs.

Public Hearing; Post Project Monitoring.

12 Hours**Total Hours: 48 Hours****Text book (s)**

1. M. N. Rao and H. V. N. Rao, Air pollution, Tata McGraw-Hill, New Delhi, 1993
2. D. Nevers, Air Pollution Control Engineering, McGraw-Hill International Ed., 1993
3. Canter, R.L, "Environmental impact Assessment ", 2nd Edition, McGraw Hill Inc, New Delhi, 1995.
4. Lohani, B., J.W. Evans, H. Ludwig, R.R. Everitt, Richard A. Carpenter, and S.L. Tu, "Environmental

Impact Assessment for Developing Countries in Asia”, Volume 1 – Overview, Asian Development Bank,1997.

- Peter Morris, Riki Therivel “Methods of Environmental Impact Assessment”, Routledge Publishers,2009

Reference (s)

- K. Wark, C. F. Warner, Air Pollution, Its Origin and Control, Harper and Row, New York, 1981
- C. S. Rao, Environmental Pollution Control Engineering, New Age International, 2005
- Becker H. A., Frank Vanclay, “The International handbook of social impact assessment” conceptual and methodological advances, Edward Elgar Publishing, 2003.
- Barry Sadler and Mary McCabe, “Environmental Impact Assessment Training Resource Manual”, United Nations Environment Programme, 2002.
- Judith Petts, “Handbook of Environmental Impact Assessment Vol. I and II”, Blackwell Science New York, 1998.
- Ministry of Environment and Forests EIA Notification and Sectoral Guides, Government of India, New Delhi, 2010.

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	30	30	--
Understand	70	70	--
Apply	--	--	100
Analyze	--	--	--
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

- Classify Air Pollutants
- Define Wind Rose
- give the plume rise behavior formula
- Define EIA
- What are the objectives of Environmental Impact Assessment (EIA)?

Understand

- Briefly discuss about the various types of gases in air pollution
- Discuss in detail about effects of air pollution on environment
- What are the basic concepts of EIA?
- Explain the various steps in preparing of EIA report.
- Explain in detail about different methods used in EIA

Apply

- A plate type ESP use in a cement plant for removing dust particles consist of 10 equal channels. The spacing between plates is 15 cm and the plates are 3 m high and 3 m long. Unit handles 20,000 m³ /h of gas. a) What is the efficiency of collection plates? b) What is the collection rate of particles having density 9.2 gm/m³? c) What should be the length of the plate for achieving efficiency of 99% keeping another parameter same? **(For Open Book Examination and not for semester end examination)**
- A highway project is proposed between Visakhapatnam to Bhubaneswar. It is recommended to prepare an environmental impact assessment report for the proposed project by considering all parameters. **(For Open Book Examination and not for semester end examination)**

Course Outcomes

1. Outline the operation of solar energy system
2. Summarize the operation of wind and biomass energy systems
3. Develop solar/wind energy systems for a given application
4. Interpret working principles of geothermal energy system
5. Summarize the operation of ocean, tidal, fuel cells, small hydro and magneto hydro energy system
6. Extend renewable energy sources to direct energy conversions & micro grids

COs - POs Mapping

COs	PO ₂	PO ₇
1	2	3
2	2	3
3	3	3
4	2	3
5	2	3
6	2	3

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I**Introduction & Solar Energy**

Introduction to renewable energy, advantages of generating power through renewable energy sources – technical & economical, Solar Energy: Physics of sun, the solar constant, extra-terrestrial and terrestrial solar radiation, instruments for measuring solar radiation and sun shine. Flat Plate and Concentrating Collectors, classification of concentrating collectors, thermal analysis of flat plate collectors, Photo voltaic energy conversion, PV cell model and characteristics, Maximum power point tracking for photovoltaic power systems. Types of Maximum power point tracking methods Perturb and Observe.

Solar applications-solar heating /cooling technique

(12 Hours)

Unit II**Wind & Bio-Mass Energy**

Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria, Maximum power generation. Principles of Bio-Conversion, Anaerobic/aerobic digestion, Types of Bio-Gas Digesters, gas yield, Combustion characteristics of bio-gas.

Utilization for cooking, IC Engine operation

(12 Hours)

Unit III**Geothermal & Ocean Energy**

Types of Resources (hydrothermal, geo-pressured, hot dry rock), types of wells, and methods of harnessing the energy (Vapour dominated, liquid dominated), Ocean thermal energy conversion, principles, Open loop & closed loop OTEC Cycles. Tidal energy- potential, conversion techniques-single basin, two basin system. Wave energy: conversion techniques.

Captive power plant

(12 Hours)

Unit IV**Direct energy conversion & introduction to Micro-grid**

Fuel cells-Principle of working of various types of fuel cells and their working, Hydrogen generation, battery energy storage system. Magneto-hydrodynamics (MHD)

Define grid, microgrid, importance of DG & microgrid, typical structure and configuration of a microgrid, AC and DC microgrids, modes of operations (grid connected & islanded).

Distributed generation (DG)

(12 Hours)

(Total: 48 Hours)

Textbook (s)

1. G.D. Rai, "Non-Conventional Energy Sources", Khanna Publishers, 2nd Edition, 2017.

2. B H Khan, "Non-conventional energy resources", Tata McGraw Hill Education Private Limited, 3rd Edition, 2015.
3. Alexis Kwasinski, Wayne Weaver, Robert S. Balog, "Micro grids and other local area power and energy systems", Cambridge University Press, 1st Edition, 2016

Reference (s)

1. Tiwari and Ghosal, "Renewable energy resources", Narosa Publishing house, 2nd Edition, 2001
2. Ranjan Rakesh, Kothari D. P. & Singal K. C., "Renewable Energy Sources and Emerging Technologies", PHI, 2nd Edition, 2013.
3. Nikos Hatziargyriou, "Micro grids: Architectures and Control", Wiley, 1st Edition.
4. Electricity Act 2003, Renewable Energy Act 2015.
5. Indian Constitution-Articles 51A, 47, 48A.

Sample Question (s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	40	40	---
Understand	60	60	50
Apply	---	---	50
Analyze	---	---	---
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Remember

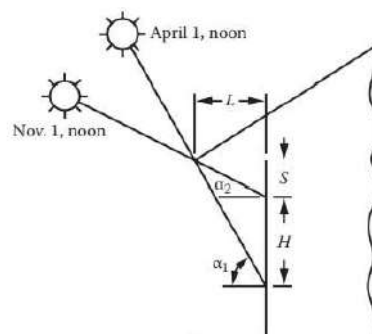
1. Define renewable energy
2. List out the advantages HAWT
3. List out the disadvantages non concentration collector
4. Define solar radiation
5. Define micro-grid

Understand

1. Explain need of micro-grid
2. Interpret faraday's laws
3. Explain closed loop OTEC Cycles system
4. Explain Principle of working of MHD Power plant
5. Compare HAWT and VAWT

Apply

1. Compute the power coefficient of wind turbine
2. Demonstrate storage of energy from battery
3. Assess magnetic flux density due to circular ring
4. Compute solar cell working
5. Assess the nature of micro-grid
6. a) Find the roof overhang L of a south-facing window of height $H = 1$ m, such that the window is completely shaded at solar noon on April 1 and not shaded at all at noon on November 1. Assume that the roof extends far beyond the window on either side. Location: Gainesville, Florida. Also, find the overhang if $S = 1.3$ m from the below figure.



- b) Repeat the above example for Canberra, Australia, for a north-facing window, such that the window is completely shaded at noon on November 1 and completely lit at noon on April 1. **(For Open Book Examination and not for semester end examination)**
7. Find the solar altitude and azimuth angles at solar noon in i) Gainesville, Florida, on February 1
ii) Canberra, Australia on February 1. Also find the sunrise and sunset times in Gainesville on that day. Since the sunrise and sunset times are calculated when the center of the sun is at the horizon, they differ from the apparent times. If we use $\alpha = -50'$, the apparent sunrise and sunset times would be 7:20 a.m. EST and 6:06 p.m. EST, respectively. **(For Open Book Examination and not for semester end examination)**
8. As a technical engineer you are appointed in a planning and commission team of govt of India. The duty has been assigned that the Leh and Ladakh people are suffering electricity problem from decade. The NDA government has declared that the power generation plant has to be operated there within a year with 10 MW generation in only renewable energy aspect.
- (i) Propose the type of plant which is more suitable to that area and having uninterrupted power supply with grid connection mode
 - (ii) Describe the advantages of that plant compared to conventional energy sources
 - (iii) What's are the measure precautions to be taken for that plant operation and maintenance purpose.
 - (iv) Give the details constructional block diagram of the power plant.
- (For Open Book Examination and not for semester end examination)**

Course Outcomes

1. Explain the role of entrepreneur in economic development
2. Demonstrate methods of generating ideas
3. Develop the business plan to start enterprises
4. Analyze various production aspects such as manufacturing costs control, marketing management and waste reduction strategies
5. Assess financial and marketing plans and control for enterprises
6. Find the institutional support for entrepreneurship

COs POs Mapping

COs	PO ₁	PO ₅	PO ₈	PO ₁₁
1	3	-	3	2
2	3	-	1	-
3	3	-	1	3
4	3	3	2	2
5	3	3	3	3
6	3	-	1	3

3-Strongly linked, 2-Moderately linked, 1-Weakly linked

Unit I

Introduction to Entrepreneurship Definition of Entrepreneur, Entrepreneurial Traits, Entrepreneur Vs. Manager, Entrepreneur Vs Entrepreneur. The Entrepreneurial decision process- Role of Entrepreneurship in Economic Developments, Ethics and Social responsibility of entrepreneurs, Woman as entrepreneur. *Opportunities for entrepreneurs in India and abroad*

12 Hours**Unit II**

Creating and starting the venture Sources of new Ideas, Methods of generating ideas, creating problems solving- Product planning and development process The business plans Writing Business plan, Evaluating Business plans, Using and implementing business plans, marketing plan, financial plan and the organizational plan launching formalities.

Nature and scope of business plan

12 Hours**Unit III**

Financing and managing the new venture Source of Capital, record keeping, recruitment, motivating and leading teams, financial controls, Marketing and sales controls. E Commerce and Entrepreneurship New venture expansion strategies and issues Features evaluation of joint ventures, acquisitions, merges, franchising, Public issues, rights issues, bonus issues

Internet advertising

12 Hours**Unit IV**

Institutional support Entrepreneurship Role of Directorate of Industries, District Industries, Centers (DICS), Industrial development Corporation (IDC), state Financial corporation (SFCs), Small Scale Industries Development Corporations (SSIDCs), Khadi and village Industries Commission (KVIC), Technical Consultancy Organization (TCO), small Industries Service Institute (SISI), National Small Industries Corporation (NSIC), Small Industries Development Bank of India (SIDBI), salient provision under Indian Factories Act, Employees State Insurance Act, Workmen's Compensation Act and payment of Bonus Act.

Labor legislation

12 Hours**Total: 48 Hours****Textbook (s)**

1. Robert Hisrich & Michael Peters, Entrepreneurship, TMH, 5th Edition, 2009.
2. Dollinger, Entrepreneurship, Pearson Education, 4th Edition, 2004.

3. Robert J. Calvin, Entrepreneurial Management, Tata McGraw-Hill Education, 2004.
4. Vasant Desai, The Dynamics of Entrepreneurial Development and Management Himalaya publishing House, 5th Edition, 2017.
5. Kaplan, Patterns of Entrepreneurship, Willey, 4th Edition, 2005

Reference (s)

1. William A. Sahlman, James Stancill, Arthur Rock, Harvard Business Review on Entrepreneurship, Harvard Business School Press, Revised Edition, 2019.
2. Gurmeet Naroola, The Entrepreneurial Connection: East Meets West in the Silicon Valley, Special edition, TiE, 2001.
3. Bill Bolton & John Thompson, Entrepreneurs Talent, Temperament, Technique, Routledge, 7th Edition, 2016.
4. Agrawal, A.N. & Agarwal, M.K., Indian Economy: Problems of Development and Planning, New Age International, 42nd Edition, 2017.
5. Gaurav Datt & Ashwani Mahajan, Dutt & Sundaram"s Indian Economy, S. Chand, 72nd Edition, 2016.
6. Srivastava, Industrial Relations Labour Laws, Vikas Publishing House, 6th Edition, 2005.
7. Aruna Kaulgud, Entrepreneurship Management by Vikas publishing house, 2003.
8. Thomas W. Zimmerer & Norman M. Scalbrorough, Essential of Entrepreneurship and small business management, PHI, 4th Edition, 2005.
9. Mary Coulter, Entrepreneurship in Action, PHI 2nd Edition, 2005.
10. ND Kapoor, Industrial Law, Sultan Chand & Sons, 14th Revised Edition, 2013.

Sample Question (s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open book examination (%)
Remember	30	40	-
Understand	70	60	-
Apply	-	-	35
Analyze	-	-	45
Evaluate	-	-	20
Create	-	-	-
Total (%)	100	100	100

Remember

1. List the different methods of generating ideas and explain any four methods.
2. List the difference between entrepreneur vs manager.
3. What are the objectives of market research?
4. What are the market research activities? List them.
5. List the important functions of IDBI.

Understand

1. Compare between entrepreneur vs manager.
2. Illustrate the characteristics or traits of an entrepreneur.
3. Outline the sources of new ideas for entrepreneur.
4. Explain the various steps involved in writing a business plan.
5. Summarize the various sources of capital required for business venture.
6. Demonstrate the role of E-commerce in entrepreneurship with its applications.
7. Illustrate marketing plan and financial plans required for an entrepreneur.
8. Show the factories act 1948.
9. Rephrase the reasons for the need of labor legislation becomes important.

Apply

1. Develop the business plan to establish a startup by taking an industrial case.
2. Identify the various sources of capital required to meet the new ideas of an entrepreneur for the economic development of a business venture.
3. Organize the role of entrepreneur in choosing the institutional supports to entrepreneurship.
4. In recent years, the entrepreneurial educator and author Steve Blank began applying lean startup principles to various US governmental agencies. Through a Hacking for Diplomacy course,

students at Stanford University began tackling problems for the Department of State. A former US ambassador to the United Nations, a State Department representative to Silicon Valley and senior advisor for technology and innovation, a retired US Army colonel, and other entrepreneurial educators joined Blank in applying lean startup methods to State Department issues. Then Secretary of State John Kerry even visited the Stanford students and said he was looking forward to the solutions students develop during the ten weeks. One project that emerged was from a group calling themselves Team Space Evaders. The team was tasked with working on the problem of satellite collision. Members charted satellite positioning data and explored how information about potential collision was shared by commercial operators and governmental entities ranging from the Federal Aviation Administration to the Department of Defense.

- a. Apply the lean startup methodology to identify potential customer segments and problems and solutions that students such as yourself could identify for the State Department on the issue of satellite collision.
- b. Choose a unique value proposition for a State Department solution to this issue. Identify a high-level concept pitch work when selling the concept within the State Department?

Analyze

1. Analyze the role of E commerce in the business plan of all production aspects and its applications to an entrepreneur.
2. Discover the opportunities for Woman as entrepreneur to start their own enterprise with production aspects in India.
3. Discover the role of National Small Industries Corporation (NSIC) in all the production aspects of entrepreneurs in establishing the new ventures.

Evaluate

1. Assess the role of Entrepreneurs and entrepreneurship institutions in the economic development of any country.
2. Estimate marketing plan and financial plans required for an entrepreneur along with the support from entrepreneurship institutions in these aspects.
3. Compare acquisitions, mergers and franchising in the evaluation process of joint ventures.

Course Outcomes

1. Illustrate various sensors and electrical motors for agricultural sector.
2. Asses the modern remote sensing technology for the agricultural development.
3. Predict the diversity of precision farming
4. Demonstrate the importance of electrical and instrument technology for the benefits of agricultural development.
5. Interpret environmental parameters with Electronics systems
6. Outline advanced agricultural technologies.

COs - POs Mapping

COs	PO ₁	PO ₂
1	2	1
2	3	2
3	3	2
4	3	2
5	3	2
6	3	3

3-Strongly linked | 2-Moderately linked| 1-Weakly linked

Unit I**Instrument technology for agriculture**

Instrument for measurement: pH, Electrical conductivity, gas analysis, humidity, leaf area, chlorophyll content and soil moisture & temperature. Use of electrical energy in agriculture, electromechanical energy conversion, Electrical motors, Selection of motors for different farming applications, renewable energy sources.

Importance of pH value, Environmental issues

12 Hours**Unit II****Precision Farming**

An introduction to precision farming. GIS/GPS positioning system for precision farming, Yield monitoring and mapping, soil sampling and analysis, Computers and Geographic information systems, Precision farming-Issues and conditions, Role of electronics in farm machinery for precision farming.

Agriculture and Forestry investigations, Atmospheric investigation,

12 Hours**Unit III**

Electronics in Agriculture Instrument for crop monitoring – moisture measurement – capacitive, infrared reflectance and resistance. Monitoring soil and weather – measurement of soil properties and meteorological parameters – irrigation control systems. Instruments for crop establishment monitoring. Crop spraying – selective crop spraying – flow control. Yield monitoring. Technology for precision farming. Instruments for protected cultivation – green house environment control – transducers and control system. Instruments and systems for crop handling processing and storage.

Role of engineering in agricultural sector, Electronic control system for grape drying process

12 Hours**Unit IV**

Advanced Agricultural Technologies: Difference between traditional and modern agricultural practices; Internet of Things (IoT), Online Marketing of agro based products, Information and Communication Technology (ICT), Mobile Technology, Agricultural Drones & Robotics, Artificial Intelligence (AI) based farming.

Governance services in agriculture sector, Role of Electronics Governance in Agricultural sector.

12 Hours**Total: 48 Hours****Text Books**

1. Curtis Johnson, "Process Control Instrumentation Technology"; 8th Edition, Pearson Education
2. Kuhar, John. E. 1977. The precision farming guide for agriculturalist. Lori J. Dhabalt, USA

Reference Books

1. De Mess M. N. Fundamental of Geographic Information System. John Willy & sons, New York, Datta S.K.1987.

2. K. Krishna Swamy, "Process Control"; New Age International Publishers
3. Manual of Soil & Water conservation Engineering. Oxford & IBH Co. Sigma & Jagmohan, 1976.

SAMPLE QUESTION (S)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open book Examination (%)
Remember	25		--
Understand	35	25	--
Apply	20	45	60
Analyse	20	30	40
Evaluate	--		--
Create	--		--
Total (%)	100	100	100

Remember

1. List the use of electrical energy in agriculture.
2. List the sensors used to access various parameters in agriculture.

Understand

1. Illustrate the use of ICT in Online marketing of agro based products.
2. Illustrate the use of Agricultural Drones & Robotics in agriculture.

Apply

1. Demonstrate the role of GPS positioning system for precision farming.
2. Demonstrate the process involved in modern agricultural practice.

[Open Book Examination Questions]

Analyse

1. Justify the statement "electronics has a positive influence on improving agriculture".
2. Outline the role of electronics in agriculture.

[Open Book Examination Questions]

Course Outcomes:

1. Classify the variety of learning algorithms.
2. Choose a learning algorithm to data using various tools of Machine Learning.
3. Identify the strengths and weaknesses of many popular machine learning approaches.
4. Examine the performance of learning algorithms and model selection.
5. Identify mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning.
6. Model Artificial Neural Networks and Deep Neural Networks in solving complex real world problems.

COs-POs Mapping

CO	PO ₂	PO ₅
1	1	2
2	3	2
3	3	1
4	3	2
5	3	2
6	2	2

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

UNIT I

Overview of Machine Learning, **Learning:** Types of Machine Learning, Hypothesis Formulation and Model Selection, **Phases of ML:** Training, Testing and Validation-Splitting, Cross Validation; **Evaluation of Machine Learning Models:** Error Analysis, Performance Indices, Confusion Matrices, The Bias-Variance Trade-off, Feature Selection; **Regression:** Linear Regression, Linear Regression with Multiple Variables, Logistic Regression.

Basic Statistics: Variance and Covariance, Correlation Vs Regression, Feature Scaling and Standardisation, Machine Learning Tools: Weka, R, Python, MATLAB.

12 Hours**UNIT II**

Learning with Trees: Constructing Decision Trees, ID3 Classifier, Constructing Rules from a Decision Trees Classification; **Graphical Models:** Bayes' Theorem, Bayesian Learning, Bayesian Networks, Naïve-Bayes Classifier, **Instance based Learning:** Nearest Neighbor Classifiers.

Modeling a Supervised Learning System, Conditional Probability

12 Hours**UNIT III**

Clustering: Similarity and Distance Measures, **Clustering Techniques:** K-Means Algorithm, Hierarchical Clustering, Clustering of Categorical Attributes; **Dimensionality Reduction:** Linear Discriminant Analysis, Principal Component Analysis; **Ensemble Learning:** Boosting, Bagging, Stacking.

Comparison of Clustering Techniques, Curse of Dimensionality.

12 Hours**UNIT IV**

Artificial Neural Networks: Model, Activation functions, Perceptron, The Multilayer Perceptron (MLP), Error Propagation, Delta Rule, Back Propagation Algorithm, **Deep Learning:** Convolutional Neural Networks (CNN), Applications, A case study on Object Recognition using CNN.

Linear Separability, Gradient Descent, XOR Gate.

12 Hours**Total: 48 Hours****Textbook (s)**

1. Stephen Marsland, "Machine Learning: An Algorithmic Perspective", (Chapman & Hall/CRC Machine Learning & Pattern Recognition), Second Edition, 2014.

- Sunila Gollapudi and Rodolfo Bonnin, "Practical Machine Learning: Experimental algorithms and techniques for machine learning and artificial intelligence", Packt Publishing Ltd., Mumbai, Second Edition, 2018.

Reference (s)

- Tom M. Mitchell, "Machine Learning ", Tata McGraw Hill, New Delhi, 2017.
- Raschka Sebastian and Mirjalili Vahid, "Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow 2", Packt Publishing Ltd., Mumbai, 3rd Edition, 2019.
- Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", The MIT Press, 2016

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	40	30	--
Understand	40	20	--
Apply	20	30	80
Analyze	--	20	20
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

SAMPLE QUESTION (S)

Remember

- Define Machine Learning.
- List the types of Machine Learning.
- State Bayes Theorem.
- What is Regularization?

Understand

- Demonstrate Linear Regression.
- Explain Back Propagation Algorithm.
- Illustrate Decision Tree Induction process in detail.
- Demonstrate Genetic Operations in detail.

Apply

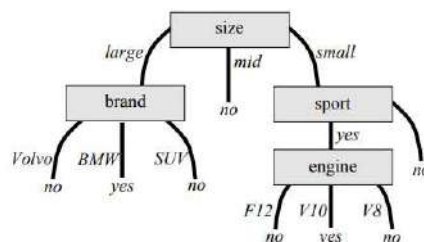
- Apply the concept of Regularization to solve overfitting problem.
- Build a Linear Regression for a given dataset.
- Apply k-Means algorithm on a given dataset to identify clusters.
- Apply Back Propagation Algorithm to the the given dataset.

Analyze

- Distinguish between Logistic Regression and SVM.
- Analyze Dimensionality Reduction using PCA
- Analyze various Neural Network Architectures in Machine Learning.

Open Book Examination

- Suppose that we want to solve the problem of finding out "what a good car is" by using Decision Tree algorithm.



- a) Generate rules from the constructed decision tree?
 - b) Which parameters required for generating the tree?
 - c) What would be the suitable values of those parameters for the given problem? Provide a short explanation for each.
 - d) Explain your answer in a clear and compact manner by providing the pseudo code of the algorithm
2. About 2/3 of your email is spam so you downloaded an open source spam filter based on word occurrences that uses the Naive Bayes classifier. Assume you collected the following regular and spam mails to train the classifier, and only three words are informative for this classification, i.e., each email is represented as a 3-dimensional binary vector whose components indicate whether the respective word is contained in the email.

'study'	'free'	'money'	Category
1	0	0	Regular
0	0	1	Regular
1	0	0	Regular
1	1	0	Regular
0	1	0	Spam
0	1	0	Spam
0	1	0	Spam
0	1	0	Spam
0	1	1	Spam
0	1	1	Spam
0	1	1	Spam

- a) You find that the spam filter uses a prior $p(\text{spam}) = 0.1$. Explain why this might be sensible.
- b) Give the following model parameters when estimated as maximum-likelihood with add-one smoothing (i.e., using pseudocounts of one).
 $P(\text{study}|\text{spam})$, $P(\text{study}|\text{regular})$, $P(\text{free}|\text{spam})$, $P(\text{free}|\text{regular})$, $P(\text{money}|\text{spam})$, $P(\text{money}|\text{regular})$
- c) Based on the prior and conditional probabilities above, give the model probability $P(\text{spam}|s)$ that the sentence $s = \text{"money for psychology study"}$ is spam.
- d) What should be the value of the prior $p(\text{spam})$ if we would like the above sentence to have the same probability as being spam as not spam, i.e., it would be classified as spam with probability 0.5?

Course Outcomes

1. Demonstrate the safety and ethical issues that may arise from industrial processes
2. Explain industrial hygiene practices and its procedures
3. Illustrate the toxic pathways and elimination of toxicity on bio organisms
4. Understand hazards arising from runaway reactions, explosions and fires, and how to deal with them.
5. Choose a suitable method for prevention of fires and explosions
6. Evaluate the process and able to do Hazards Identification and risks Risk Assessment

COs - POs Mapping

COs	PO ₁	PO ₂	PO ₃	PO ₆	PO ₈
1	2	2	1	3	3
2	1	2	1	3	3
3	3	2	3	1	1
4	3	1			
5	3	3	3		2
6	3	3	3	3	2

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I**Introduction to Safety & Industrial Hygiene**

Safety programs, Engineering ethics, Accident and Loss Statistics, Acceptable Risk, Public Perceptions, The nature of the Accident Process, Inherent Safety, Government of India and OSHA regulations, Industrial Hygiene, Identification, Evaluation & Control

Lethal dosage-Material Safety Data Sheets

12 Hours**Unit II****Toxicology, Fires and Explosions**

how toxicants enter biological organisms, how toxicants are eliminated from biological organisms, effects of toxicants on biological organisms The fire triangle, Distinction between fire and explosions, Definitions, Flammability characteristics of liquids and vapors, MOC and inerting, ignition energy, Auto ignition, Auto oxidation, Adiabatic compression, Explosions

Firefighting equipment-Personal protecting equipment-Building fire safety codes

12 Hours**Unit III****Designs to Prevent Fires and Explosions**

Inerting, static electricity, controlling static electricity, explosion proof equipment and instruments, ventilation, sprinkler systems, miscellaneous designs for preventing fires and explosions

Work permit-Earthling-Color codes for identification of process

12 Hours**Unit IV****Hazards Identification and Risk Assessment**

Process hazards checklists, hazards surveys, hazards and operability studies, safety reviews, other methods. Review of probability theory, event trees, fault trees, QRA and LOPA

Health and safety foundation-5S Practice-Emergency procedures

12 Hours**Total: 48 Hours****Text book (s)**

1. D. A. Crowl, J. F. Louvar, Chemical Process Safety: Fundamentals with Applications, 3rd Ed., Prentice Hall, 2011
2. Reese, Charles D. Industrial Safety and Health for People-oriented Services. CRC Press, 2008

Reference (s)

1. H.H.Fawcett and W.S.Wood, Safety and Accident Prevention in Chemical Operations, John Wiley and sons, 2nd Ed., New York, 1982
2. Hammer, Willie, and Dennis Price. Occupational safety management and engineering. Pearson College Division, 2001

3. R. K. Sinnott, Coulson and Richardson's Chemical Engineering series Vol.6, Butterworth-Heinemann Ltd. 1996

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open book Examination (%)
Remember	20	20	--
Understand	30	20	--
Apply	30	20	35
Open book Questions	20	30	35
Evaluate	--	20	30
Create	--	--	--
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define terms hazard and accidents
2. List three-step of accidents process?
3. Define terms LD and ED
4. Define any two methods of representation of toxicants dose concentration
5. List any four reversible effects that caused by toxic exposure
6. Describe four phases in any industrial hygiene
7. Define terms risk, loss prevention

Understand

1. Identify the initiation, propagation, and termination steps for motor accident
2. Would you say chemicals do more good than harm, more harm than good, or about the same amount of each?
3. Explain about how toxicants enter biological organisms
4. Explain the key responsibilities' of professional engineers
5. Explain the inherent safety techniques that are used in the chemical industry
6. Explain how toxicants are eliminated from biological organisms
7. List the ingredients of safety program for outstanding safety program

Apply

1. An employee works in a plant with a FAR of 4. If this employee works a 4-hr shift, 200 days per year, what are the expected deaths per person per year?
2. Air contains 5 ppm of diethylamide (TLV-TWA of 5 ppm), 20 ppm of cyclohexanol (TLV-TWA of 50 ppm), and 10 ppm of propylene oxide (TLV-TWA of 2 ppm). What is the mixture TLV-TWA and has this level been exceeded?
3. The following accident report has been filed. Failure of a threaded 1½" drain connection on a rich oil line at the base of an absorber tower in a large (1.35 MCF/D) gas producing plant allowed the release of rich oil and gas at 850 psi and -40°F. The resulting vapor cloud probably ignited from the ignition system of engine driven re compressors. The 75' high × 10' diameter absorber tower eventually collapsed across the pipe rack and on two exchanger trains. Breaking pipelines added more fuel to the fire. Severe flame impingement on an 11,000-horsepower gas turbine-driven compressor, waste heat recovery, and super-heater train resulted in its near total destruction. Identify the initiation, propagation, and termination steps for this accident
4. A process has a reported FAR of 2. If an employee works a standard 8-hr shift 300 days per year, compute the deaths per person per year

Open book Questions

1. Can gate valves be placed between a vessel relief and its vessel
2. Liquid levels in storage tanks are frequently determined by measuring the pressure at the bottom of the tank. In one such tank the material stored in the tank was changed and an overflow resulted. Why?
3. How to convert your kitchen in to XP area
4. Does LOPA really replace 90% of the QRA?

Course Outcomes

1. Interpret the main concepts, key technologies, strengths, and limitations of cloud computing and the possible applications for state-of-the-art cloud computing
2. Illustrate various problems and evaluate related cloud computing solutions.
3. Apply the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud and hybrid cloud to different problems.
4. Analyze cloud provider for a defined environment and to a specific platform in a cost effective way.
5. Analyze case studies to derive the best practice model to apply when developing and deploying cloud based applications
6. Build a virtual machine with a machine image

COs - POs Mapping

COs	PO ₂	PO ₆	PO ₇	PO ₈	PO ₁₂
1	3	2	1	2	1
2	3	2	1	3	2
3	3	2	1	1	3
4	2	2	2	2	2
5	3	2	1	3	1
6	2	2	3	2	2

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Syllabus**Unit I****Understanding Cloud Computing**

Cloud computing: Introduction, Cloud application architectures, Value of cloud computing, Cloud Infrastructure models, Cloud Services, History of Cloud Computing, Advantages of Cloud Computing, Disadvantages of Cloud Computing, Companies in the Cloud Today, Amazon Web Services, Windows Azure, Google services, IBM Cloud Before the move into the cloud- Know Your Software Licenses, The Shift to a Cloud Cost Model, Service Levels for Cloud Applications Ready for the cloud: Web Application Design, Machine Image Design, Privacy Design, Design, Database Management.

Tata Cloud- Salesforce.com

12 Hours**Unit II****Virtual Machines and Virtualization of Clusters and Data Centers**

Implementation Levels of Virtualization, Virtualization Structures/Tools and Mechanisms, Virtualization of CPU, Memory, and I/O Devices, Virtual Clusters and Resource Management, Virtualization for Data-Center Automation Case Studies: Cloud centers in detail, Comparing approaches, Xen, Eucalyptus, Cloud Stack, and Open Stack

VMware- KVM.

12 Hours**Unit III****Cloud Computing Software Security Fundamentals**

Cloud information Security Objectives, Cloud Security Services, Relevant Cloud Security Design Principles, Secure Cloud Software Requirements, Approaches to Cloud Software Requirements Engineering, Cloud Security Policy Implementation. Cloud Computing Risk Issues: The CIA Triad, Privacy and Compliance Risks, Threats to Infrastructure Data and Access Control, Cloud Access Control Issues, Cloud Service Provider Risks.

Security concepts-Confidentiality-privacy-integrity-authentication-non-repudiation-availabilit- access control- defense in depth- least privilege

12 Hours**Unit IV****Cloud Programming and Software Environments**

Features of Cloud and Grid Platforms, Parallel and Distributed Programming Paradigms, Programming Support of Google App Engine, Programming on Amazon AWS and Microsoft Azure, Emerging Cloud Software Environments.

Ubiquitous Cloud: Cloud Trends in supporting Ubiquitous Computing, Performance of Distributed Systems and the Cloud.

12 Hours
Total: 48 Hours

Textbook (s)

1. George Reese, Cloud Application Architectures, 1st Edition O’Reilly Media, 2009
2. Ronald L.Krutz and Russell Dean Vines, Cloud Security, 1st Edition, Wiley Publishing, 2010

Reference (s)

1. Michael Miller, Cloud Computing-Web Based Applications that change the way you work and collaborate online, 1st Edition, Pearson Education, Publishing, 2011
2. Kai Hwang, Geoffrey C Fox and Jack J.Dongarra, Distributed & Cloud Computing from Parallel Processing to the Internet of Things , 1st Edition, MK Publishing, 2010
3. David S Linthicum, Cloud Computing and SOA Convergence in Your Enterprise: A Step-by-Step Guide, 1st Edition, Addison-Wesley, 2009

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	40	45	--
Understand	40	45	--
Apply	20	10	80
Analyze	--	--	20
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Sample Question (S)

Remember

1. Define Cloud Computing
2. List types of virtualization
3. Define proactive scaling
4. What is CIA Triad?

Understand

1. Explain different cloud Infrastructure models
2. Explain different levels of virtualization
3. Explain about cloud Network security in detail?
4. Explain about Recovery Point Objective.

Apply

1. Explain any IaaS service provided by Amazon
2. What is cloud Stack?
3. How disaster recovery planning can be done
4. How Web Application Design is used in designing cloud applications

Analyze

1. Compare cloud center and service infrastructure.
2. Analyze different cloud services provided by Amazon
3. With neat diagram explain the functioning of Xen Architecture.
4. List and explain various cloud service providers risks.

Course Outcomes

1. Apply the knowledge of finding roots of nonlinear equations and different errors in series approximations
2. Understand the consistency and inconsistency of linear system of equations
3. Evaluate the solution of Initial and Boundary value problems
4. Perform numerical differentiation and integration.
5. Analyze the solution of PDEs under given conditions
6. Apply Knowledge of numerical techniques to Engineering problems

COs-POs Mapping

COs	PO ₁	PO ₂
1	3	2
2	3	2
3	3	3
4	3	2
5	3	3
6	3	3

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I**Errors in numerical calculations and Solutions of algebraic and transcendental equations**

Absolute, relative and percentage errors, a general error formula, errors in a series approximation

Locating Roots of Equations with one variable: Secant method, Muller's method

Solution of nonlinear equations - Introduction, Iteration method, Newton-Raphson method

Bisection method, Regula Falsi method, Order of convergence.

12 Hours**Unit II****Solution of Linear Systems and Interpolation**

Direct methods -LU Decomposition, Iterative methods -Jacobi method, Gauss-Seidel method, Interpolating polynomials using finite differences- Bessel interpolation, Piecewise and spline interpolation -Piecewise Linear interpolation, Quadratic spline interpolation

Matrix inversion method, Lagrange and Newton's divided difference interpolation formula.

12 Hours**Unit III****Numerical Integration and BVP (ODE)**

Newton-Cotes methods (Weddle's rule)

Solution of BVP - Finite difference method, shooting method, the cubic spline method

Trapezoidal Rule, Simpson's 1/3 Rule and Simpson's 3/8 Rule.

12 Hours**Unit IV****Numerical solutions of PDEs**

Introduction, Finite difference approximations to derivatives, Solutions of Laplace & Poisson equations using Jacobi's, Gauss-Seidel & SOR methods. Solution of parabolic equation using -Bender-Schmidt & Crank-Nicolson methods. Solution of hyperbolic equation

Classification of second order partial differential equations, Canonical forms.

12 Hours**Textbook(s)**

1. M. K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical methods for Scientific and Engineering Computation, 4th Edition, New Age International publishers, New Delhi.
2. S.S.Sastry, Introductory methods of numerical analysis, 4th Edition, PHI.
3. B. S. Grewal, Higher Engineering Mathematics, 42nd Edition, Khanna publishers, New Delhi.

Reference(s)

1. S. C. Chapra & R. P. Canale, Numerical Methods for Engineers, 6th Edition, McGraw Hill(2012).

- Cleve Moler, Numerical Computing with MATLAB, SIAM.

Sample Question(s)

Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	30	30	-
Understand	40	40	-
Apply	30	30	60
Analyze	--	--	30
Evaluate	--	--	10
Create	--	--	--
Total (%)	100	100	100

Remember

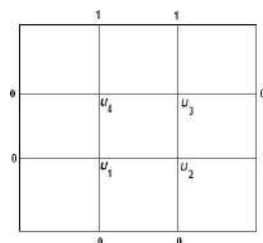
- List out different Errors in Numerical calculations.
- List the three numerical methods to solve Algebraic and Transcendental equations.
- Define initial and boundary value problem for Ordinary differential equations.
- List the numerical methods in solving Laplace's, partial differential equations i.e. Parabolic and hyperbolic.

Understand

- Summarize the Absolute, relative and percentage Errors.
- Illustrate the procedure for Newton-Raphson method for finding root of an algebraic equation.
- Explain the mechanism involved in LU decomposition method in solving linear system.
- Explain spline interpolation formula.

Apply

- Given $f(x) = \sin x$, construct the Taylor series approximations of orders 0 to 7 at $x = \pi/3$.
- Apply Newton-Raphson method to find a root of the equation $x^3 - 2x - 5 = 0$.
- Given the set of data points (1,-8), (2,-1) and (3, 18) satisfying the function $y = f(x)$, find the linear splines.satisfying the given data. Determine the approximate values of $y(2.5)$ and $y(2)$.
- Apply Gauss-Seidel's method to solve Laplace equation for the region given in the figure.



Analyze

- Compare the roots obtained from Secant method, Muller's methods and explain which method is preferable.
- Analyze the physical significance of spline's interpolation formula.
- Differentiate shooting and cubic splines methods for numerical integration.
- Analyze the platform for the application of Laplace Equation.

21BS003 Functional Materials and Applications

3 0 0 3

Course Outcomes

1. Understand crystal structures of various solids.
2. Explain the X-ray diffraction and its use in the study of solids.
3. Acquire knowledge of Dielectric materials and their applications.
4. Discuss magnetism, different magnetic materials and their properties.
5. Demonstrate the applications of magnetic materials.
6. Summarize core knowledge and applications of various new materials.

COs-POs Mapping

COs	PO1	PO7
CO ₁	3	2
CO ₂	3	2
CO ₃	3	2
CO ₄	3	2
CO ₅	3	2
CO ₆	3	2

3 – Strongly Correlating; 2 – Moderately Correlating & 1 – Weakly Correlating

Unit I

Crystal structures

Classification of Solids – Amorphous and Crystalline, Lattice Points and Space Lattice - Basis and Crystal Structure, Unit cell, Primitive cell, Crystal Systems and Bravais Lattices, Common Crystal Structures: Diamond, Zinc Blende, NaCl and CsCl Structure - Directions, Planes and Miller Indices, Separation Between Lattice Planes in a Cubic Crystal, X-Ray Diffraction – Brag's Law, Reciprocal Lattice, Concept of Brillouin Zone, Laue's Equation. Inter Planar Distance - The Laue Method of XRD - The Powder Method - Analysis of Polycrystalline Pattern (Debye-Scherrer Method).

Packing fraction and coordination number of SC, BCC and FCC.

11+3 Hours

Unit II

Dielectric Materials

Introduction, Dielectric Materials, Dielectric Constant, Polarization, D, E and P relation, Types of Polarizations, Electronic Polarization, Ionic Polarization, Orientation Polarization, Interfacial or Space Charge Polarization, Local Field or Internal Field, Clausius-Mossotti Equation, Frequency Dependence of Polarization, Piezoelectricity and piezoelectric materials, Types of Dielectric Materials, Dielectric Loss, Dielectric Break Down. Ferroelectric Materials, Applications of Dielectric Materials.

Pyroelectrics, Electrets.

11+4 Hours

Unit III

Magnetic materials

Introduction, Magnetic Permeability, Susceptibility, Magnetization, B, H and M relation, Origin of Magnetism in Materials, Bohr Magneton, Classification of Magnetic Materials (Dia, Para and Ferro magnetics), Weiss theory of Ferromagnetism, Hysteresis of Ferromagnetic Material, Soft and Hard Magnetic Materials, Ferrimagnetic (Ferrites) Materials, Anti-ferromagnetic Materials, Applications of Magnetic Materials - Microwave Applications, Storage and Memory Elements Applications - Magnetoresistance Materials.

Nuclear Magnetic Resonance (NMR) Electron Paramagnetic Resonance (EPR).

11+4 Hours

Unit IV

New Materials

Metallic glasses, Shape Memory Alloys: Copper, Nickel and Titanium based Alloys, Graphene and its Properties - Ceramics: Types and Applications - Composites: Classification, role of Matrix and Reinforcement, Processing of Fibre Reinforced Plastics and Fibre Reinforced Metals - Biomaterials:

hydroxyapatite, PMMA, Silicone, Nanomaterials: ZnO, TiO₂ Properties and Applications - Sensors: Chemical Sensors, Bio-Sensors, Conducting, Semiconducting and Photoresponsive Polymers. *Nanosensors, Application of Nanosensors.*

12+4 Hours
Total: 45+15 Hours

Textbook (s)

1. Charles Kittel Introduction to solid state Physics, John Wiley & Sons, In, 8th edition, 2012.
2. Wahab, M.A. Solid State Physics: Structure and Properties of Materials. Narosa Publishing House, 2009.
3. Raghavan, V. Materials Science and Engineering: A First course, PHI Learning, 2015.
4. Balasubramaniam, R., Callister's Materials Science and Engineering, Wiley India Pvt. Ltd. 2014.

Reference (s)

1. Smith, W.F., Hashemi, J. & Prakash. R. Materials Science and Engineering, Tata Mcgraw Hill Education Pvt. Ltd., 2014.
2. Askeland, D. Materials Science and Engineering, Brooks/Cole Publishing Company 2010.
3. G. L. Hornyak, H.F. Tibbals, J. Dutta, J. J. Moore, Introduction to Nanoscience and Nanotechnology CRC Press, 2008

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	25	25	20
Understand	35	35	20
Apply	30	30	30
Analyze	10	10	30
Evaluate	--	-	-
Create	--	-	-
Total (%)	100	100	100

Sample question (s)

Remember

1. Define Bravais Lattices.
2. List any four applications of dielectric materials.
3. State Bohr Magneton.

Understand

1. Explain the concept of Brillion zone.
2. Differentiate Soft and Hard ferromagnetic materials
3. Describe the processing of fibre reinforced plastics and fibre reinforced metals.

Apply

1. Identify the principle behind the working of X-ray diffraction.
2. Develop the relation between D, E and P in dielectrics.
3. Choose the energies involved in origin of domains in ferromagnetic material.

Analyze

1. Examine the properties of metallic glasses and shape memory alloys.
2. Analyze why ferrites are advantageous for use as transformer cores.
3. Distinguish between conducting and semiconducting polymers.

Open Book Exam Question

1. Discuss uses of Shape memory alloys in health sector.

Course Outcomes

1. Classify the sources and types of municipal solid wastes
2. Understand the on-site storage methods and source reduction technique
3. Explain the different collection methods and need for transfer station
4. Demonstrate the off-site processing techniques for resources recovery from solid waste
5. Summarize the various disposal methods of solid wastes
6. Understand different types, handling of hazardous waste

COs-POs Mapping

COs	PO3	PO7	PO12
1	2	3	3
2	2	3	3
3	2	3	3
4	3	3	3
5	3	3	3
6	3	3	3

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I**Basics of Solid Waste**

Sources and types of municipal solid waste – Waste generation rates – Factors affecting generation, composition, characteristics – Methods of sampling – Effects of improper disposal of solid wastes – Public health and environmental effects – Elements of solid waste management – Municipal solid waste rules – Role of NGO's, EPA

11+4 Hours

Unit II**Source Reduction, Storage, Collection and Transfer**

Source Reduction and Storage: Source reduction of waste – Reduction, Reuse, Recycling and Recover – Segregation of wastes at source – Onsite storage methods – Materials used for containers.

Collection and Transfer: Methods of Collection – types of vehicles – Vehicle time management – Manpower requirement – collection routes; transfer stations – selection of location, operation & maintenance; options under Indian conditions

11+4 Hours

Unit III**Processing and Waste Disposal**

Processing: Objectives of waste processing – Physical Processing techniques and Equipment; Resource recovery from solid waste composting and biomethanation; Thermal processing options.

Disposal: Land disposal of solid waste- Sanitary landfills – site selection, design and operation of sanitary landfills – Landfill liners – Management of leachate and landfill gas – Landfill bioreactor – Dumpsite Rehabilitation.

12+3 Hours

Unit IV**Hazardous Waste Management**

Basics of Hazardous Waste: Need for hazardous waste management – Sources of hazardous wastes- Characteristics of Hazardous Waste- Effects on community – Basic Terminology and classification – Storage and collection of hazardous wastes.

Types of Hazardous Waste: Types, Classification, Handling, Storage and Disposal of Nuclear Waste, e-Waste, Biomedical waste and Chemical Waste.

11+4 Hours

Total: 45+15 Hours

Textbook (s)

1. George Tchobanoglous and Frank Kreith., "Handbook of Solid waste management", McGraw Hill, New York, 2002
2. John Pitchel., "Waste Management Practices-Municipal, Hazardous and industrial", CRC Press, Taylor and Francis, New York, 2014

Reference (s)

1. CPHEEO, "Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation", Government of India, New Delhi, 2014
2. William, A. Worrell., P. Aarne Vesilind., "Solid Waste Engineering", Cengage Learning, 2012
3. Ramachandra, T. V., "Management of Municipal Solid Waste", TERI Press, New Delhi, 2009
4. Marc J. Rogoff and Francois Screve., "Waste to Energy Technologies and Project Implementation", Second Edition, Noyes Publication, USA, 2011

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	25	25	-
Understand	75	75	100
Apply	-	-	-
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Sample Question (S)

Remember

1. Define Solid Waste
2. List the need of transfer station
3. List any two onsite processing technique
4. What are the important factors governing the selection of solid waste?
5. List the characteristics of solid waste

Understand

1. Explain in detail about functional elements of solid waste
2. Explain in detail about different components of landfill
3. Explain in detail about source, types, handling and disposal methods of biomedical waste.
4. A city is having a population of 10 lakhs. Suggest a suitable storage system by dividing into different zone, develop a collection routes with all its components (collection time, frequency, manpower and type of vehicle). It is also required to adopt a suitable onsite processing technique and best disposal methods for the solid waste. **(For open Book Examination, not for Semester Examination)**
5. Explain in detail about India's Underground Radioactive Waste Disposal site at Gogi in Karnataka? **(For open Book Examination, not for Semester Examination)**

Course Outcomes

1. Outline the dynamics of electric vehicles
2. Illustrate the layout of electric and hybrid electric vehicles
3. Identify suitable vehicle for the given application
4. Outline the speed torque characteristics of various drives
5. Summarize the various factors affecting the capacity of battery
6. Identify suitable drive and battery for the given application

COs - POs Mapping

COs	PO ₂	PO ₃	PO ₁₂
1	2	2	3
2	2	2	3
3	3	3	3
4	2	2	3
5	2	2	3
6	3	3	3

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I**Fundamentals of Vehicle**

Vehicle Resistance, Types: Rolling Resistance, Grading resistance, Aerodynamic drag, Calculation of total force, Total Tractive Force, Wheel torque, Wheel Speed, Motor Torque, Motor Speed, Motor Power, Battery Power, Transmission: Differential, Clutch, gear box.

Battery design for two-wheeler

12 Hours

Unit II**Electric & Hybrid Electric Vehicles**

Components, General Layout and Configurations of EV, EV Classification, Components of hybrid EV, General layout of HEV, Types of Hybrid EV.

Comparison with Internal combustion Engine: Benefits and Challenges

12 Hours

Unit III**Electric Vehicle Motors & Drives**

DC Motor Drive-Construction, Principle, Closed loop control of dc drive, Induction Motor Drive-Construction, Principle, V/f control of Induction motor drive, BLDC motor drive- Construction, Principle, Speed & Torque Control of bldc drive.

PMSM drive

12 Hours

Unit IV**Cells and Batteries**

Conversion of chemical energy to electrical energy, Classification of cells, factors affecting the capacity of the battery, Ampere-Hour & Watt- Hour efficiency, trickle charging, indications of full charged battery, Battery design Performance criteria for EV batteries, Vehicle propulsion factors, Power and energy requirements.

battery power calculation for an EV

12 Hours

Total: 48 Hours

Text Book(s):

1. Tom Denton, "Electric and Hybrid Vehicles", CRC Press publications, second edition, 2020.
2. Chris Mi, Abul Masrur and David Wenzhong Gao, "Hybrid Electric Vehicles-Principles and Applications with Practical Perspectives", A John Wiley & Sons, Ltd., Publication, 2nd Edition, 2017.
3. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press; 3rd edition, 2021.

4. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", CRC Press, 2018.

Reference Book(s):

1. Amgad Elgowainy, "Electric, Hybrid, and Fuel Cell Vehicles", Springer publisher, New York, NY, 2021.
2. Amir Khajepour, Saber Fallah, Avesta Goodarzi, "Electric and hybrid vehicles technologies, modelling and control a mechatronic approach" Wiley Publications, first edition, 2014.
3. Per Enge, Nick Enge, Stephen Zoepf, "Electric Vehicle Engineering", McGraw-Hill Education, first edition, 2021.
4. Joeri Van Mierlo, "Plug in hybrid Electric vehicle(PHEV)", MDPI journal, special edition, 2019.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	50	50	---
Understand	50	50	---
Apply			100
Analyze	---	---	---
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample question (s)

Remember

1. List the challenges faced by hybrid electric vehicle.
2. List any five differences between electric vehicle and hybrid electric vehicle.
3. List the components of a hybrid electric vehicle.
4. List the advantages and disadvantages of hybrid cars.
5. State and explain the dynamic equation of vehicle motion.

Understand

1. Explain the term rolling resistance and aerodynamic drag in vehicles and derive the expression for vehicle translational speed from fundamentals.
2. Obtain the mathematical modeling of electric vehicle to describe its performance.
3. Explain various electric drive train topologies.
4. Explain the design of a Hybrid Electric Vehicle (HEV) as a case study.
5. Explain the two-quadrant operation of chopper DC motor drive with suitable waveforms for electric Vehicle

Apply

- | | |
|-----------------------------|-------------------------|
| 1. Rolling resistance | 0.015 |
| Vehicle Mass | 111 Kg |
| Driver Mass | 80 Kg |
| Acceleration due to gravity | 9.81 m/s ² |
| Grade | 0° |
| Area | 0.875 m ² |
| Air Density | 1.225 Kg/m ³ |
| Drag Coefficient | 0.22 |
| Radius of Wheel | 0.1524 m |
| Gear ratio | 7.4 |
| Transmission efficiency | 0.85 |
| Motor efficiency | 0.9 |
| GVM | 191 Kg |
| GVW | 1873.1 Kg |
| Motor controller efficiency | 0.85 |

Design the motor requirement for the above system.

(For Open Book Examination and not for semester end examination)

2. Determine the torque vs speed and torque vs current characteristics for a separately excited dc motor with the following parameters: 2.3hp, 220V, 600 rpm, $R_a=1.39$ ohms, $L_a=0.00182$ H, $K_b=0.331$ volt/rad/sec. The machine has rated field excitation and its armature is fed a constant voltage of 220 V dc.

(For Open Book Examination and not for semester end examination)

Course Outcome(s)

1. Design organization structure and implement management principles in real time business environment
2. Establish layouts for different types of industries, manufacturing, process and service sectors
3. Elaborate productivity and profitability by implementing work study and SQC
4. Select and maintain skilled and sufficient manpower for various business proposals
5. Find total production time and cost by using networking techniques
6. Enunciate a best method of making a product in the production process

COs- POs Mapping

COs	PO ₁	PO ₁₁
1	3	2
2	3	2
3	3	1
4	3	2
5	2	1
6	3	1

3 Strongly linked | 2 Moderately linked | 1 Weakly linked

Unit I

Evolution of Management Thought-Organizational Structures - Douglas McGregor's Theory X and Theory Y, Maslow's Hierarchy of Human Needs, Systems Approach to Management. Designing. Basic concepts related to Organization, Departmentation and Decentralization, Types of mechanistic and organic structures of organization (Line organization, Line and staff organization, functional organization, Committee organization, matrix organization, Virtual Organization) and their merits, demerits and suitability. Cellular Organization and team structure

12 Hours

Unit II

Facilities location- Work study - Plant location, definition, factors affecting the plant location, comparison of rural and urban sites methods for selection of plant, Matrix approach, Plant Layout; definition, objectives, types of production, types of plant layout, various data analyzing forms, travel chart. Definition, objectives, method study; definition, objectives, steps involved, various types of associated charts. Work measurement- definition, time study, steps involved, equipment, different methods of performance rating, allowances, standard time calculation. Work Sampling, definition, steps involved. Standard time calculations and differences with time study

12 Hours

Unit III

Materials Management-Quality Control- Objectives, Inventory, functions, types, associated costs, inventory classification techniques, EOQ, ABC and VED analysis. Inspection and quality control, types of inspections, Statistical Quality Control; techniques, variables and attributes, assignable and non assignable causes, variable control charts, and R charts, attributes control charts, p charts and c charts. sampling plans. Introduction to TQM, Quality Circles, ISO 9000 series procedures

12 Hours

Unit IV

Introduction to PERT / CPM-Introduction to Human Resource Management - Project management, network modelling; PERT/CPM Time and cost estimations. Functions of HRM, Job Evaluation, different types of evaluation methods, Job description, Merit Rating, difference with job evaluation. Different methods of merit ratings, wage incentives.

12 Hours

Total: 48 Hours

Textbook(s)

1. O.P. Khanna, Industrial Engineering and Management, S Chand & Co Publications, 3rd Edition, 2013
2. Teslang Martand, Industrial Engineering and Production Management, S Chand & Co Publications, 1st Edition, 2002
3. Phillip E Hicks, Industrial Engineering and Management; a new perspective, TMH publications, 2nd Edition, 1994
4. H.T. Amrine, J. A. Ritchey and O.S. Hulley, Manufacturing Organization and Management, Prentice-Hall, 2nd Edition, 1966
5. P.C. Tripathi and P.N. Reddy, Principles of Management, TMH Publications, 4th Edition, 2012

Reference(s)

1. H. Koontz & H. Weihrich, Essentials of Management, Tata McGraw Hill, 8th Edition, 2010
2. Paneer Selvam, Production and Operations Management, PHI, 3rd Edition, 2012

Sample Question (s)**Internal Assessment Pattern**

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	35	35	-
Understand	45	35	20
Apply	20	30	80
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

1. List the five objectives of work study
2. List any four merits and demerits of committee organization
3. Define Mc-Gregor"s theory X and theory Y
4. List the three types of plant layout
5. List any four functions of HRM
6. List the three functions of material management?

Understand

1. Explain the factors effecting plant locations
2. Explain about purchase management
3. Write about Statistical Quality Control-techniques
4. Compare the Mc-Gregor"s Theory X and Theory Y

Apply

1. Explain the attribute charts
2. Compare the PERT and CPM
3. Explain about stores management and stores records
4. What are the different types of evaluation methods and explain them?
5. Identify duties of purchase manager

Course Outcomes

1. Summarize the hardware and software of Arduino development board
2. Explain the working of I/O devices
3. Demonstrate the interfacing and programming of I/O devices with Arduino
4. Explain the working of different sensors
5. Demonstrate the interfacing and programming of sensors with Arduino
6. Organize different applications of Arduino

COs – POs Mapping

COs	PO1	PO2
1	2	
2	2	
3	3	2
4	2	
5	3	2
6	3	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I**Arduino – Hardware and Software**

Features of Arduino UNO Board, Arduino IDE Software, Serial Peripheral Interface (SPI) Communication Protocol, Inter-Integrated Circuit (I2C) Communication Protocol, Structure of Arduino Programming, Function,

Features of ATmega328, map function

12 Hours**Unit II****Interfacing and programming of IO Devices with Arduino**

Interfacing and programming of Arduino with LED, Seven-segment display, LCD, push button, keypad, relay for high voltage devices, interfacing and programming of Arduino using PWM technique.

DC motor and Motor Driver IC L293D

12 Hours**Unit III****Interfacing and programming of Sensors with Arduino**

Interfacing and programming of Arduino with temperature sensor, humidity and temperature sensor, light dependent register, touch sensor, smoke detector, ultrasonic sensor, soil moisture sensor.

Rain sensor and Bluetooth

12 Hours**Unit IV****Arduino based simple projects**

Obstacle Detection and Warning System, Gas Leakage Detection, Burglar Detection, Weather Monitoring System, Plant Watering System

Mobile Phone Controlled Light

12 Hours**Total: 48 Hours****Textbook (s)**

1. Yogesh Misra, Programming and Interfacing with Arduino, CRC Press, 1st Edition, 2021
2. James A. Langbridge, Arduino Sketches: Tools and Techniques for Programming Wizardry, Wiley, January 2015,

Reference (s)

1. Michael Margolis, "Arduino Cookbook", First Edition, March 2011, O'Reilly Media, Inc

Sample Question (S)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember			--
Understand	70	40	--
Apply	30	50	50
Analyze	--	10	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. Recall the microcontroller used in Arduino UNO board.
2. List the pin numbers having PWM capabilities in Arduino UNO board.

Understand

1. Exemplify the SPI protocol for on board communication interface.
2. Exemplify the I2C protocol for on board communication interface.
3. Demonstrate the purpose of compiler and linker in firmware design.
4. Illustrate the different components of Arduino UNO board.
5. Illustrate the working of capacitive touch sensor.

Apply

1. Construct an interfacing diagram of LCD with Arduino board and develop the software to display a message from the 5th row and 2nd column of LCD.
2. Construct an interfacing circuit of 220 V ac operated bulb with Arduino board and develop the software to turn it on and off after a delay of 10 seconds.
3. Implement the hardware and software for automatic street light logic.

Course Outcomes:

At the end of the course, students will be able to:

1. Understand the fundamentals of data science.
2. Explain how data is collected, managed, and stored for data science.
3. Analyze the data by applying various techniques.
4. Explore data visualization techniques.
5. Explore the technologies for data visualization
6. Investigate several applications in data science.

COs-POs Mapping

CO	PO2	PO3	PO4
1	1	2	2
2	3	2	2
3	3	1	2
4	3	2	2
5	3	2	2
6	2	2	2

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit-I: Fundamentals of Data science**12 Hours**

Introduction to core concepts and technologies: Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications.

Data collection and management: Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, using multiple data sources.

Unit-II: Data analysis**12 Hours**

Basics of Data Analysis: Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and arithmetic, Samples/CLT.

Algorithms: Basic machine learning algorithms, Linear regression, SVM, Naive Bayes.

Unit-III: Data visualization**12 Hours**

Introduction, Types of data visualization, Data for visualization: Data types, Data encodings, Retinal variables, Mapping variables to encodings, Visual encodings.

Unit-IV: Data Science-Applications**12 Hours**

Applications of Data Science, Technologies for visualisation, Bokeh (Python), Recent trends in various data collection and analysis techniques, various visualization techniques, application development methods of used in data science.

Total: 48 Hours**Textbook:**

1. Jeffrey S. Saltz, Jeffrey M. Stanton, "An Introduction to Data Science", SAGE Publications, 2018.
2. Anil K. Maheshwari, "Data Analytics Made Accessible", 2015 (Online)
3. Laura Igual, Santi Seguí, "Introduction to Data Science A Python Approach to Concepts, Techniques and Applications", Springer Publications, 2014

Reference(s)

1. Glenn J. Myatt, Wayne P. Johnson: Making Sense of Data I: A Practical Guide to Exploratory Data Analysis and Data Mining, 2nd Edition, Wiley, 2014
2. Joseph F Hair, Barry J. Babin, Rolph E. Anderson, William C. Black: Multivariate Data Analysis Cengage, 2018

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination ¹ (%)
Remember	40	30	--
Understand	40	20	--
Apply	20	30	80
Analyze	--	20	20
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

SAMPLE QUESTION (S)

Remember

1. What is data science.
2. Define purpose of different data visualtion aids
3. List any two steps involved in EDA.

Understand

1. Explain different data representation
2. Explain the role of various data grouping methods
3. Explain purpose of hypothesis testing in detail

Apply

1. Apply various visual aids to identify behavior of data
2. Make use of Multivariate Analysis methods for data nanlysis
3. Examine data with various distribution function

Analyze

1. Comapre and contrast varius data grouping methods.
2. Distinguish various methods to address problems with dummy variables
3. Examine various string handling methods

Evaluate

1. Evaluate the statistics of a given dataset
2. Justify the importance of data skewness
3. Measure data dispersion methods on a dataset

Open Book Exam Questions

Question 1:

Perform below analysis on a house price prediction dataset.

- a) Univariate Analysis
 - i. Analysis of a numerical feature
 - ii. Analysis of a categorical feature
- b) Bivariate Analysis
 - i. Relationship of a numerical feature with another numerical feature
 - ii. Relationship of a numerical feature with a categorical feature

Question 2:

Perform below analysis on weather prediction dataset.

- a. Correlation Analysis
 - a. Correlation Heat Map
 - b. Zoomed Heat Map
- b. Investgation of missing values
 - a. What's missing? to what extent?

Visualizing missing values in a dataframe

21CH003 Industrial Ecology for Sustainable Development

3 0 0 3

Course Outcomes

1. Explain the basic concepts of industrial ecology and sustainability
2. Compare between biological and industrial organisms
3. Analyze energy and material flows in natural and technical systems at different scales
4. Utilize the concept of life cycle assessment before designing a product or process
5. Utilize the concept of industrial symbiosis to develop sustainable technical collaboration
6. Evaluate the availability of renewable and fossil resources for industrial processes

CO-PO Mapping

CO	PO ₂	PO ₆	PO ₇
1	3	3	3
2	3	3	3
3	3	3	3
4	3	3	3
5	3	3	3
6	3	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Sustainability as Applied to Industrial Ecology

The tragedy of the commons–Technological evolution and the master (IPAT) equation–Industrial ecology activities and sustainability–Linking industrial ecology activities to sustainability–Greening of engineering Biological and industrial organisms and ecosystems–Engineering by biological and industrial organisms–Metabolisms of biological and industrial organisms–Risk assessment and management–Social dimensions of industrial ecology

Limits to Growth

11+4 Hours

Unit II

Sustainable Engineering & Life Cycle Assessment

Green chemistry and engineering–Process design and life cycle–Green technology and sustainability–Design for Environment and Sustainability

Concept of life cycle assessment–The LCA framework–Goal setting and scope determination–Life cycle of industrial products–Impact and interpretation–Limitations of LCA

Life cycle assessment of processes

11+4 Hours

Unit III

Industrial Ecosystems

Ecosystems and food chains–Food web–Industrial symbiosis–Designing and developing symbiotic industrial ecosystem–Eco-industrial Park - Material flow analysis, utility of material flow analysis

Eco-industrial Park initiatives around the world

11+4 Hours

Unit IV

Energy and Industrial Ecology

Energy and organisms–Energy and the product life cycle–Energy and mineral resources–Energy and industrial ecology

Industrial ecology and sustainable engineering in developing economies–Industrial ecology and sustainability in the corporation

Energy efficiency through industrial ecology

12+3 Hours

Total: 45+15 Hours

Text Book (s)

1. T. E. Graedel, B. R. Allenby, Industrial Ecology and Sustainable Engineering, 1st Ed., Pearson, USA. 2010

Reference Book (s)

1. R. U. Ayres, L. W. Ayres, A Handbook of Industrial Ecology, Edward Elgar Publishing, 2002

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Assignment test (%)
Remember	20	20	10
Understand	40	40	40
Apply	40	40	50
Analyze	--	--	
Evaluate	--	--	-
Create	--	--	--
Total (%)	100	100	100

Sample Question (s)

Remember

1. State any two drivers for and barriers to industrial ecosystems.
2. State the order of precedence for approaches to packing in decreasing order of preference.

Understand

1. What do you mean by 3-2 heuristic in industrial symbiosis?
2. What do you mean by material flow analysis?
3. Present any two thoughts/desirables on development in lesser developed countries.

Apply

1. What are the three types of consumption pattern? What is sustainable consumption and how does IPAT equation help in achieving sustainable consumption
2. Discuss about rapidly developing country and slowly developing country dynamics and perspectives?
3. Discuss about the alternative corporate approaches including defensive, cost-oriented and proactive approaches to environment and sustainability?
4. For a metal processing system using only virgin raw material with $E_p = 31 \text{ GJ/t}$, $E_f = 5 \text{ GJ/t}$, $E_m = 5 \text{ GJ/t}$ and $\beta = 0.1$, compute the energy consumed per kg of output material (ϕ). E_p , E_f , and E_m are the energy consumed during production, fabrication, and manufacture and, β is the fraction of throughput that is reused as prompt scrap.
5. Discuss the concept of circular economy. How was it applied to the entire economy in China?

13+4 Hours

21IT003 Fundamentals of Mobile Computing

3 0 0 3

Course Outcomes

At the end of the course, students will be able to

1. Interpret the GSM architecture and its services.
2. Understand the various wireless applications and study technical feasibility of various mobile applications.
3. Utilize the mobile network layer protocols and its functionalities.
4. Explain any existing or new models of mobile environments for 4G networks
5. Understand platform, protocols and related concepts of Ad hoc and Enterprise wireless networks
6. Understand IP and TCP layers of Mobile Communications

CO - PO Mapping

COs	PO ₁	PO ₇
1	3	2
2	3	2
3	3	2
4	3	2
5	3	1
6	3	1

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Syllabus

Unit I

12 Hours

Introduction: Mobile Communications and Mobile Computing – Paradigm, Promises/Novel Applications and Impediments and Architecture; Mobile and Handheld Devices, Limitations of Mobile and Handheld Devices. Global System for Mobile Communication (GSM): Services, System Architecture, Radio Interfaces, Protocols, Localization, Calling, Handover, New Data Services, GPRS Architecture, GPRS Network Nodes.

Evolution of Mobile computing

Unit II

12 Hours

Medium Access Control (MAC) : Motivation for a specialized MAC (Hidden and exposed terminals, Near and far terminals), Wireless LAN/(IEEE 802.11) architecture, key IEEE802.11 a/b/c/d/e/g/i/n/T/ac/ standards. Wireless Application Protocol (WAP): The Mobile Internet standard, WAP Gateway and Protocols, wireless markup Languages (WML). Wireless Local Loop (WLL): Introduction to WLL Architecture.

wireless Local Loop Technologies

Unit III

12 Hours

Mobile Network Layer : IP and Mobile IP Network Layers, Packet Delivery and Handover Management, Location Management, Registration, Tunneling and Encapsulation, Mobile Transport Layer : Conventional TCP/IP Protocols, Indirect TCP, Snooping TCP, Mobile TCP. Third Generation (4G) Mobile Services: Comparison of different generations, Introduction to International Mobile Telecommunications 2000 (IMT 2000) vision.

Wideband Code Division Multiple Access, Time out freezing

Unit IV

12 Hours

Mobile Ad hoc Networks (MANETs) : Introduction, Applications & Challenges of a MANET, Routing, Classification of Routing Algorithms, Algorithms such as DSR, AODV, DSDV, etc. , Mobile Agents, Service

Discovery ,case study using NS2 –traffic analysis using CBR and VBR Wireless Enterprise Networks:
 Introduction to Virtual Networks, Blue tooth technology.
Blue tooth Protocols.

Total: 48 Hours

Textbook (s)

1. Jochen Schiller, “Mobile Communications”, Addison-Wesley, Second Edition, 2009.
2. Raj Kamal, “Mobile Computing”, Oxford University Press, 2007, ISBN: 0195686772

Reference (s)

1. Asoke K Talukder, Hasan Ahmed, Roopa R Yavagal, “Mobile Computing, Technology Applications and Service Creation” Second Edition, 2010 McGraw Hill.
2. Martin Sauter, “From GSM to LTE-Advanced: An Introduction to Mobile Networks and Mobile Broadband,” Second Edition, 2014 Wiley.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	30	30	-
Understand	70	70	40
Apply	-	-	60
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	--
Total (%)	100	100	100

Sample Question (S)

Remember

1. List any four Application of Mobile Computing
2. Define Mobile Computing

Understand

1. Explain Mobile Ad hoc Networks
2. Explain the role Blue tooth technology in Mobile Computing
3. Illustrate Classification of Routing Algorithms

Apply

1. Discuss about Mobile transport Layer
2. Illustrate Blue tooth technology
3. Describe classification of Routing algorithms
4. Illustrate challenges of MANET

Open Book Exam Questions

1. Why “MAC protocol designed for infrastructure based wireless network may not work satisfactory in infrastructure less environment “ – justify?
2. why the traditional IP cannot be used in a mobile network. What are the main differences between the traditional IP and the mobile IP? How does mobile IP support mobile hubs?

Course Outcomes

1. Understand the conventional and renewable energy sources.
2. Explain hydrogen production, storage and use as fuel.
3. Illustrate the concept and types of fuel cells.
4. Understand the various solar cells and their applications
5. Demonstrate energy storage through batteries and their technologies.
6. Understand the concept of supercapacitor and their characteristics.

COs-POs Mapping

COs	PO1	PO7
1	2	3
2	2	3
3	2	3
4	2	3
5	2	3
6	1	3

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I**Renewable and Nonrenewable Energy sources**

Introduction - Conventional fossil fuels- Coal and natural gas- Renewable energy sources-Photovoltaics- Hydrogen production from biomass, geothermal, solar and wind energy - Fuel cells-principle and working. *Advantages of renewable energy technologies.*

10+3 Hours**Unit II****Fuel Cells & Hydrogen Production and Storage**

Materials for hydrogen production - storage, utilization & dispensing - Electrochemical: Electrolysis, Photo electro chemical. Biological: Photo Biological, Anaerobic Digestion Fermentative Micro- organisms. Physical and chemical properties - Principles of fuel cells, types of fuel cells, fuels for fuel cells, low, medium and high temperature fuel cells, power generation by fuel cells. *Applications of fuel cells.*

13+4 Hours**Unit III****Photovoltaics**

Solar Spectrum, Solar constant-Materials for Renewable energy conversion- Photovoltaics - Silicon (Si) solar cells, Crystalline/ Semi crystalline/ Amorphous Si solar cells- Thin film solar cells. Photochemical cells, photocatalytic, Mechanism of photovoltaics- Factors affecting electron transfer. Organic solar cells-polymer solar cells- perovskite solar cells. *Hybrid solar cells*

11+4 Hours**Unit-IV****Energy Storage- Batteries and super capacitors**

Batteries -Primary and Secondary cells-Conventional battery technologies- merits and demerits- Recent battery technologies- Lithium-ion- Sodium ion- Metal-air batteries - Design, Fabrication, operation and evaluation-Super capacitors- Fundamentals of Electrochemical Super capacitors, Electrode and electrolyte interfaces and their capacitances, Charge-Discharge characteristics, Energy/power density. *Applications of batteries and super capacitors*

11+4 Hours**Total: 45+15 Hours**

Text Book (S)

1. B.K. Hodge, "Alternate Energy Systems and Applications", John Wiley & sons, Inc., 2010.
2. C. Brabec, "Organic Photovoltaics", Wiley-VCH, 2008.
3. Norman S. Allen (Ed.), "Photochemistry and Photophysics of Polymeric Materials", 2010.
4. V. Hacker, S. Mitsushima (Eds.), "Fuel Cells and Hydrogen: From Fundamentals to Applied Research", Elsevier, 2018.
5. C. Daniel and Jürgen O. Besenhard, "Handbook of Battery Materials", Wiley-VCH Verlag, 2011.
6. A. Yu, V. Chabot, and J. Zhang, "Electrochemical Super capacitors for Energy Storage and delivery" 1st Ed., CRC Press, Taylor & Francis group, 2012.
7. L. Liu and S. Bashir, "Advanced Nanomaterials and their Applications in Renewable Energy", Elsevier Science, 2015.

Reference (S)

1. X. Moya David and Muñoz-Rojas (Ed.), "Materials for Sustainable Energy Applications Conversion, Storage, Transmission, and Consumption", Pan Stanford Publishing Pvt. Ltd. 2016.
2. Alan J. Heeger, Niyazi Serdar Sariciftci and Ebinazar B. Namdas, "Semiconducting and Metallic Polymers", Oxford Univ Press 2010.
3. W. Streicher and M. Kaltschmitt (Ed.) "Renewable energy. Technology, economics and environment", Springer, 2007.
4. N. Armaroli, V. Balzani and N. Serpone, "Powering Planet Earth – Energy Solutions for the Future", WILEY- VCH, 2012.
5. A.J. Bard, L.R. Faulkner, "Electrochemical Methods, Fundamentals and Application". Wiley, 2001.
6. K.E. Aifantis, S.A. Hackney, and R. V. Kumar (Ed.) "High Energy Density Lithium Batteries Materials, Engineering, Applications", WILEY-VCH Verlag GmbH & Co. KGaA, 2010.
7. Delivery Fundamentals and Applications, Taylor & Francis Group, 2013.
8. F. Beguin and E. Frackowiak, "Super capacitors- Materials, Systems, and Applications", Wiley- VCH Verlag GmbH & Co. 2013.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	25	25	10
Understand	45	45	10
Apply	30	30	80
Analyze	--	-	-
Evaluate	--	-	-
Create	--	-	-
Total (%)	100	100	100

Sample question (s)**Remember**

1. What is renewable energy?
2. List any two Conventional fossil fuels.
3. State primary and secondary batteries.

Understand

1. Explain the concept of fuel cell.
2. Differentiate organic and polymer solar cells.
3. Describe the processing of power generation by fuel cells.

Apply

1. Identify the principle behind wind energy.
2. Select various factors affecting electrontransfer in solar cells.
3. Choose materials for Photovoltaics.

Open Book Exam

1. You are given the job of fabricating a super capacitor.
 - (a) Which process/ process parameter you choose for material synthesis? What factors do you consider while choosing the process?
 - (b) Among the cost, raw material availability, morphology, material category (crystalline/ glass/ composite), which factor do you think should be given priority? Justify your answer.
 - (c) *Change in material morphology leads to change in the super capacitance behaviour.* State True or False and Justify your answer.

21BS005 Applied Linear Algebra for Engineers

3 0 0 3

Course Outcomes

1. Understand about Eigen values and Eigen vectors of Complex matrices
2. Compute solution of system of non-homogenous equations
3. Learn the basic notion of Vector Spaces and understand related properties
4. Study about Basis and Dimensions of vector spaces
5. Understand the properties of Linear Transformations
6. Apply the concept of Vector Spaces using Linear Transformations

COs – POs Mapping

COs	PO ₁	PO ₁₂
1	3	1
2	3	1
3	3	1
4	3	1
5	3	1
6	3	1

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I

Complex Matrices & System of Non-Homogenous Equations

Complex Matrices - Introduction, Hermitian, Skew-Hermitian and Unitary Matrices, Properties of Hermitian, Skew-Hermitian and Unitary Matrices, Eigen values and Eigen Vectors of Complex Matrices, Power method.

System of non-homogenous equations - Cholesky's Method, Crout's Method

Invertible Matrices and their some applications in Cryptography

12+3 Hours

Unit II

Vector Spaces

Vector Spaces - Introduction, Properties of Vector Spaces, Subspaces, Algebra of Subspaces, Linear combination of vectors, Linear Span, Linear Independence and Dependence of vectors (All theorems without Proof)

Study of Linear Independence and Dependence using Wronskian

11+4 Hours

Unit III

Finite dimensional Vector Spaces

Finite Dimensional Vector Spaces - Basis of Vector Space, Basis Extension Theorem, Dimension of a Vector Space, Dimension of a Subspace, Quotient Spaces and Dimension of Quotient space (All theorems without Proof)

Study about Row and column spaces

11+4 Hours

Unit IV

Linear transformations and Applications

Linear transformations - Linear Operators, Properties of Linear Transformations, Algebra of Linear Operators, Range Space of Linear Transformation, Null space of Linear Transformation, Rank and Nullity of Linear Transformations, Rank-Nullity Theorem (All theorems without Proof)

Application of Linear Transformation to Animation on a Computer screen

11+4 Hours

Total:45+15 Hours

Textbook (s)

1. J.N Sharma and A. R Vasista, "Linear Algebra", Krishna's Educational Publishers, Meerut, 2021.
2. B. S. Grewal, "Higher Engineering Mathematics", 42nd Ed., Khanna Publishers, New Delhi, 2014.
3. A Ramkrishna Prasad, "Kreyszig's,Mathematical Methods",Wiley India,2009

Reference (s)

1. Shanti Narayana ,A Text Book of Matrices, , S. Chand Publishing,2020.

2. Jin Ho Kwak and Sungpyo Hong, "Linear Algebra", 2nd Ed., Springer, 2004.
3. T K V Iyengar, B Krishna Gandhi, S Ranganatham and M.V.S.S.N Prasad, "Mathematical Methods", S. Chand, 2016.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	20	20	-
Understand	50	50	30
Apply	30	30	70
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Sample question (s)

Remember

1. Define Skew Hermitian matrix.
2. Define Vector Space.

Understand

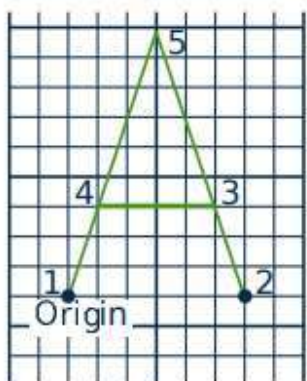
1. Show that the set $S = \{(-1, 0, 1, 0), (1, -3, 2, -4), (1, 3, -4, -2), (2, 2, -4, 0)\}$ in R^4 is linearly dependent.
2. Show that $T: R^3 \rightarrow R^3$ is defined by $T(x, y, z) = (x - y, 0, y + z)$ is a linear transformation.

Apply

1. Using Power Method, determine the largest Eigen value and the corresponding Eigen vector for the matrix $A = \begin{pmatrix} 2 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 2 \end{pmatrix}$.
2. Find rank of the transformation $T: R^2 \rightarrow R^3$ defined by $T(x, y) = (x + y, x - y, y)$ using Rank-Nullity Theorem.

Open book Examination question(s)

1. Model the matrix for the figure given below.
 - i. Draw the image corresponding to the matrix obtained by multiplying $\begin{bmatrix} 1 & 0.2 \\ 0 & 1 \end{bmatrix}$ with obtained matrix in (i)
 - ii. Sketch the image and write the corresponding matrix by rotating the following figure through the angle $\frac{\pi}{6}$ about the point $\begin{bmatrix} 4 \\ 5 \end{bmatrix}$.



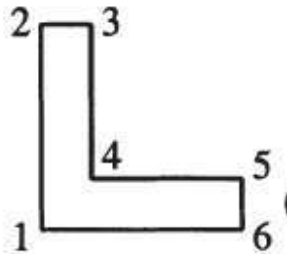
2. Consider the letter L as shown in the figure below. L can be represented by a matrix with coordinates of the vertices as

1 2 3 4 5 6

$$\begin{bmatrix} 0.0 & 0.0 & 0.5 & 0.5 & 2.0 & 2.0 \\ 0.0 & 2.0 & 2.0 & 0.5 & 0.5 & 0.0 \end{bmatrix} = A$$

Where first row values represents X-coordinates and second row values represents Y-coordinates.

- i. Model the matrix obtained by multiplying $B = \begin{bmatrix} 1 & 0.25 \\ 0 & 1 \end{bmatrix}$ with A.
- ii. Sketch the image of (i).
- iii. What kind of figure can you have, if $B^T A$ replaced with BA .



21CE019 Green Buildings

3 0 0 3

Course Outcomes

1. Apply the knowledge in development of green field infrastructure in relation to sustainable environment.
2. Explain Green Building specifications and various eco-friendly materials
3. Choose and size building components, as well as energy and environmental systems suitable for different categories of buildings to achieve the smallest feasible life-time environmental impact.
4. Utilize a variety of tools and methodologies suitable for evaluating the resource consumption and overall environmental performance of buildings in different stages of their life cycles
5. Summarize importance of solar energy in green buildings.
6. Demonstrate the passive energy system and components of building fabrics and materials

COs-POs Mapping 33

COs	PO1	PO7	PO12
1	3	3	2
2	2	3	1
3	3	3	1
4	3	3	1
5	3	3	2
6	3	3	2

3-Strongly linked | 2-Moderately linked | 1- Weakly linked

Unit I

Green Buildings

Definition of Green Buildings, typical features of green buildings, benefits of Green Buildings, Green building Principles, Sustainable site selection and planning of buildings to maximize comfort, day lighting, ventilation, planning for storm water drainage
Smart Buildings, technologies

11+4 Hours

Unit II

Environmentally Friendly Building Materials and Technologies

Natural Materials like bamboo, timber, rammed earth, stabilized mud blocks, hollow blocks, lime & lime pozzolana cements, materials from agro and industrial waste, ferro-cement, alternative roofing systems, various paints reducing the heat gain of the building, etc.
Ferro Concrete, bamboo as a construction material

11+4 Hours

Unit III

Energy and Resource Conservation and Use of Renewable Energy Resources

Need for energy conservation, various forms of energy used in buildings, embodied energy of materials, energy used in transportation and construction processes- water conservation systems in buildings- water harvesting in buildings - waste to energy management in residential complexes or gated communities. Wind and Solar Energy Harvesting.
Case studies of fully solar energy-based buildings in India

12+3 Hours

Unit IV

Building Resources and Green Building Rating Systems

Passive energy system design, Building envelope, orientation and components of building fabric and shading, Construction of curtain walls, Sourcing and recycling of building materials. Introduction to Leadership in Energy and Environment Design (LEED), Green Rating systems for Integrated Habitat Assessment - Modular wastewater treatment systems for built environment.
Building management systems, LEED certification

11+4 Hours

Total: 45+15 Hours

Textbook (s)

1. K.S.Jagadish, B. U. Venkataramareddy, K. S. Nanjundarao, Alternative Building Materials and Technologies, 2nd Ed., New Age International, 2007
2. Osman Attmann, Green Architecture Advanced Technologies and Materials, McGraw Hill, 2010

Reference (s)

1. Kibert, C. J, Sustainable Construction:Green Building Design and Delivery, 3 rd Ed., John Wiley & Sons, Inc., 2012
2. G. D. Rai, Non-Conventional Energy Resources,6th Ed., Khanna Publishers.1988
3. Greening Building – Green Congress, US. (Web).
4. Sustainable Building Design Manual. Vol 1 and 2, Teri, New Delhi, 2004.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	50	50	-
Understand	50	50	100
Apply	-	-	-
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Sample Question (s)**Remember**

1. What are the aims and objectives of green building development?
2. What is a LEED Building?
3. What are the principles of green buildings?
4. Discuss the various forms of energy and energy scenario in India **(For Open Book Examination, not for Semester Examination)**

Understand

1. Explain various rating systems for the assessment of sustainability.
2. Explain the necessity of understanding basic concepts of green buildings and intelligent buildings.
3. Explain about the various rating systems for the assessment of sustainability **(For Open Book Examination, not for Semester Examination).**

Course Outcomes

1. Understand various terms related to sustainability
2. Understand the estimation and valuation of different energy sources
3. Identify the key issues and lessons learned for sustainable development
4. Outline the technical performance of sustainability
5. Summarize the interaction of energy systems with the environment
6. Identify the environmental benefits and implications of sustainable energy

COs - POs Mapping

COs	PO ₂	PO ₃	PO ₁₂
1	2	1	1
2	3	2	2
3	2	1	2
4	2	1	1
5	3	2	2
6	1	2	2

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit-I**Fundamentals of Sustainable Energy**

Sustainable Energy Systems: Issues for the 21st century, Critical challenges for a sustainable energy future, definitions, indicators, Key energy stakeholders, Energy: conservation, efficiency. *investments and divestments.*

12 Hours**Unit-II****Estimations and Evaluation of Energy resources**

Units of measurement: Energy and Power, comparison of different forms of energy, the energy life cycle, estimation and valuation of fossil mineral fuels, estimation and valuation of Nuclear Fuel Resources, Estimation and Valuation of Renewable Energy Resources. *Lessons for Sustainable Development*

12 Hours**Unit III****Technical Performance: Efficiency and Production Rates**

The Relation of Technical Performance to Sustainability, An Introduction to Methods of Thermodynamic Analysis, The Importance of Rate Processes in Energy Conversion, Chemical Rate Processes, The Physical Transport of Heat, Energy Requirements for Gas Separation Processes, Use and Abuse of Time Scales, *Energy Resources and Energy Conversion: Fertile Common Ground.*

12 Hours**Unit IV****Local, Regional, and Global Environmental Effects of Energy**

How Energy Systems Interact with the Environment, Adverse Environmental Effects over Local and Regional Length Scales, Global Climate Change: Environmental Consequences over Planetary Length Scales, Attribution of Environmental Damage to Energy Utilization, Methods of Environmental Protection, Environmental Benefits of Energy, *Implications for Sustainable Energy.*

12 Hours**Total: 48 Hours****Text Book(s):**

1. Jefferson W. Tester, Elisabeth M. Drake, Michael J. Driscoll, Michael W. Golay, and William A. Peters "Sustainable Energy: Choosing among options" Second edition, The MIT Press Cambridge, Massachusetts London, England, 2012.62
2. Frank kreith, Susan krumdieck, "Principles of sustainable energy systems", second edition, CRC Press, Taylor and Francis group, 2008.

Reference Book(s):

1. Ibrahim Dincer and Marc A. Rosen (Eds.), "Exergy. Energy, Environment and Sustainable Development" second edition, Elsevier sciences, 2013
2. Course readings and other reference are available on Canvas: <https://umich.instructure.com/>
3. US Department of Energy, Energy Information Administration: <http://www.eia.doe.gov/>
4. International Energy Agency: <http://iea.org/>
5. US DOE Office of Energy Efficiency and Renewable Energy (EERE) <http://energy.gov/eere/office-energyefficiency-renewable-energy>
6. Renewable Energy World News and Network: <http://www.renewableenergyworld.com>
7. OpenEnergyInfo Gateway to world energy information/ data http://en.openei.org/wiki/Main_Page

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	25	15	---
Understand	50	35	---
Apply	25	50	100
Analyze	---	---	---
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)**Remember**

1. What are the critical challenges of future sustainable energy?
2. What is energy conservation?

Understand

1. Explain how estimation is done for nuclear fuel resources?
2. Demonstrate the rate process in energy conservation?

Apply

1. Taking the recent World Energy Council and United Nations resource-base figures for the total amount of fossil energy in the ground worldwide as 356,000 quads, how long will it take to exhaust our fossil resources, assuming that we can recover one-half of the resource base and that usage grows at 3% per year? The world currently consumes about 400 quads of primary energy per year, of which 85% is from fossil sources. (Hint: you will need to account for the compounding, exponential growth effect of the 3% per year increase in consumption.) Identify the key factors from the case study of the city Paris- a city of modernity?
2. How much power in MW are you delivering to your car when you fill it up at a self-service gas station?
3. A novel heat engine is being considered for producing work from the thermal energy contained in the wastewater discharge from a large food-processing plant. On an average day, 35 ° C wastewater leaves the plant and is discharged into the ocean at 1,000 gallons per minute. If the average annual ocean temperature is 10 ° C at that location, what is the maximum power that could be produced by this heat engine? What would be the thermal cycle efficiency of your maximum power engine? You can assume that the heat capacity of water at constant pressure is constant at 4,200 J/kg K.

(For Open Book Examination and not for semester end examination)

4. Estimate the rate of heat loss due to radiation from a covered pot of water at 95 ° C. How does this compare with the 60 W that is lost due only to convection and conduction losses? What amount of energy input would be needed to maintain the water at its boiling point for 30 minutes? The polished stainless steel pot is cylindrical, 20 cm in diameter and 14 cm high, with a tight-fitting flat cover. The air temperature in the kitchen is about 25 ° C. State any assumptions you make in deriving your estimates.

(For Open Book Examination and not for semester end examination)

Course Outcome(s)

1. Demonstrate the deming philosophy as a frame work for TQM
2. Identify customer needs to enhance the quality management
3. Appraise the employee's involvement critically for effective team work requirements
4. Describe several techniques of quality management tools
5. Apply benchmarking and FMEA processes for effective quality management.
6. Apply ISO standards for design and development of products and services.

COs-POs Mapping

COs	PO ₁	PO ₁₁
1	2	3
2	1	3
3	2	1
4	3	2
5	2	1
6	3	1

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

Introduction- Definition and principles of quality Evolution of Quality Quality Planning Quality policies and objectives. Dimensions of product and service quality. Contributions of Demeing, Juran and Crosby Customer focus. Customer stratification, Customers complaints and Customer retention.

Basic concepts of TQM, Barriers to TQM, customer feedback.

Unit II

TQM Principles-Employee's- Motivation, Empowerment, Team & Team work, Recognition and Reward, Performance appraisal Benefitsof employee's involvement, performance measure, balance score card, Continuous Process Improvement, PDCA cycle, Kaizen 5s, Reengineering Supplier relationship Partnering, Supplier selection, Supplier rating.

Unit III

TQM Techniques- New management tools, New and old 7 QC tools, an affinity diagram, tree diagram, matrix diagram, Six sigma methodology, infrastructure, implementation, Bench marking, process, Taguchi philosophy of quality control.

TPM concepts, improvement needs

Unit IV

Quality System- Need for ISO 9000 system, Advantages, Clauses of ISO 9000, Implementation of ISO 9000, Quality costs, Quality auditing, Case studies of TQM implementation in manufacturing and service sectors including IT industry.

Need for quality system, Principles, Revision standards.

Total: 48 Hours

Textbook(s)

1. Dale H. Besterfiled, Total Quality Management, Pearson, 3rd Revised Edition, 2011
2. Subbaraj Ramasamy, Total Quality Management, Tata McGraw Hills, New Delhi, 4th Edition, 2012

Reference(s)

1. James R. Evans and William M. Lindsay, The Management and Control of Quality, 8th Edition, First Indian Edition, Cengage Learning, 2012
2. K. C. Jain and A. K. Chitale, Quality Assurance and Total Quality Management, Khanna Publication, 3rd Edition, 2003
3. Suganthi, L and Anand Samuel, Total Quality Management, Prentice Hall (India) Pvt. Ltd., 3rd Edition, 2006
4. Douglas C. Montgomery, Design and Analysis of Experiments Minitab manual, JWS, 7th Edition, 2010

Web Reference(s)

1. <https://archive.nptel.ac.in/courses/110/101/110101010/>
2. <https://archive.nptel.ac.in/courses/112/107/112107259/>

Video Reference(s)

1. <https://archive.nptel.ac.in/courses/112/106/112106249/>
2. <https://archive.nptel.ac.in/courses/112/106/112106253/>

Sample Question(s)**Internal Assessment Pattern**

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	25	35	-
Understand	35	25	20
Apply	40	40	80
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

1. Examine the definitions of quality by the quality gurus
2. List out the basic concepts of TQM
3. Define quality policies and its objectives
4. Explain the five distinct dimensions of quality
5. Explain the purpose of different quality statements

Understand

1. Explain concepts of continuous improvement
2. Briefly explain the eight pillars of TPM
3. Contrast and compare Six Sigma with total quality management
4. Explain mutually beneficial supplier relationships

Apply

1. Discuss in detail about the various tasks of employee involvement.
2. Enumerate the seven magnificent quality tools which form a significant part of the six-sigma tool kit.
3. Discuss the eight quality principles of management on which ISO9000 is based.

Course Outcomes

1. Illustrate the importance of analog and digital communication.
2. Interpret the concept of satellite communication.
3. Asses the operation of RADAR
4. Explain various Fibre Optic phenomena
5. Demonstrate the characteristics of fibre optic elements.
6. Outline the operation of cellular system.

COs – POs Mapping

COs	PO1	PO2
1	2	
2	2	
3	3	2
4	2	
5	3	2
6	3	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

Principles Of Communication

Structure of Communication, Transmission modes (Simplex, half duplex, Full duplex), Synchronous and Asynchronous transmission, Serial and Parallel communication, Need of Modulation, Amplitude modulation (Definition and block diagram of AM wave generation), Frequency modulation (Definition and block diagram of FM wave generation), Pulse code modulation block diagram, Digital modulation techniques(Definitions and block diagram), Multiplexing (Definition and need), Time division multiplexing, Frequency division multiplexing.

Frequency spectrum, Phase modulation

12 Hours

Unit II

Satellite Communication & Radar

Microwave link, advantages of satellite communication system, classification of satellites, Geo-stationary Satellites, azimuth, elevation, apogee, perigee, transponder, up-link and down-link frequencies, active and passive satellites, applications of satellites, Introduction to Radar system – Radar range equation.

DTH, CW radar – MTI radar

12 Hours

Unit III

Fibre Optic Communication

Optical fibre – Total Internal Reflection (TIR), Numerical Aperture(NA), Modes and dispersion, losses in fibres, fibre optic cables – Splices, connectors, optical couplers , switches & relays – optical emitters (LED & LASER diode) – optical detectors (PIN diode & APD)

Dense wavelength division multiplexing (DWDM), Submarine cables..

12 Hours

Unit IV

Mobile Communication

Evolution of mobile radio communication, Cellular concept and frequency reuse, Radio wave propagation issues in personal wireless systems, Multipath fading, Multiple Access Techniques-FDMA, TDMA and CDMA systems.

Parameters of mobile multipath channels, Antenna systems in mobile radio.

12 Hours

Total: 48 Hours

Text Book(s):

1. B. P. Lathi, " Modern Digital And Analog Communication Systems: ", Oxford University Press, 2017.
2. Frenzel, " Communication Electronics", TMH, 2017.
3. Trimothy Pratt, Charles W. Bostian, Jeremy E. Allnutt, "Satellite Communications", John Wiley and Sons, 2002.

Reference Book(s)

1. Gottapu Sasibhushana Rao, " Mobile and Cellular Communications". Pearson Education, 2013
2. Gerd Keiser "[Optical Fiber Communication](#)", TMH, 2017.
3. Andreas F.Molisch "Wireless Communications", Wiley, Second Edition, 2014.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	25	15	--
Understand	75	50	--
Apply	--	35	50
Analyze	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

REMEMBER

1. Define Nyquist rate
2. Define numerical aperture
3. List the two technologies of 4G communication

UNDERSTAND

1. Explain the basic elements of digital communication system
2. Illustrate the characteristics of geo stationary satellites
3. Explain the evolution of mobile communication system

APPLY

1. Find the Nyquist rate of the following.
(i) $x(t) = 5\cos(1000\pi t)\cos(4000\pi t)$ (ii) $y(t) = \text{Sinc}(200t)$
2. Find the maximum range of Radar for the following specifications –
Peak power transmitted by the Radar, $P_t = 250\text{KW}$
Gain of transmitting Antenna, $G = 4000$
Effective aperture of the receiving Antenna, $A_e = 4\text{m}^2$
Radar cross section of the target, $\sigma = 25\text{m}^2$
Power of minimum detectable signal, $S_{\text{min}} = 10^{-12}\text{W}$
3. A step-index fiber has a core index of refraction of $n_1 = 1.425$. The cut-off angle for light entering the fiber from air is found to be 8.50° . Find the following (a) numerical aperture of the fiber? (b) index of refraction of the cladding of this fiber?

Course Outcomes

1. Illustrate the scope of Artificial Intelligence (AI) in gaming and expert systems.
2. Demonstrate various applications of AI related to perception and biometrics.
3. Summarize and learn different case studies in classification and recognition systems.
4. Describe and apply natural language processing techniques for designing AI Bots,
5. Illustrate the role of AI in robotics.
6. Demonstrate the state of AI in solving human labor problems for social equity.

CO-PO Mapping:

COs	PO2	PO3	PO6	PO7
1	3	3	3	1
2	3	3	3	1
3	3	3	2	1
4	2	2	2	2
5	2	1	1	2
6	1	1	1	3

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit -I**11 Hours****AI for Everyone, Gaming and Expert Systems**

AI for Everyone- What is AI? AI Explosion, AI at work, AI at Society, Applications of AI. **Gaming** – Games as search problems- Mini Max Search, Alpha Beta Cutt-Offs, State of the Art Games- Chess & Checkers Problem. **Expert Systems-** Representing and using domain knowledge, Expert System Shells, Explanation and Knowledge Acquisition. **Case Study:** MYCIN expert system using AI to identify bacteria causing Infections.

AI in fashion, Ethics and Laws for Holding AI,

Unit -II**13 Hours****Perceptions and Biometrics**

Perceptions-Image formation, Image Processing Operations, Object Recognition by appearance, Reconstructing the 3D world, Object recognition from structural information. Using Vision for manipulation and navigation. **Biometrics-** Understanding the Biometric fingerprints, facials, voice, iris, palm, and finger vein patterns Identifies Challenges in Biometric Systems. **Case Study I:** Text Classification System **Case Study II:** Face Recognition System.

AI in Health Care, Medical Imaging, Role, Benefits and Tools of AI

Unit -III**12 Hours****Natural Language Processing and Natural Language Communication**

Natural Language Processing- Language Models, Text Classification, Information Retrieval and Information Extraction. **Natural Language Communication-** Phrase Structure Grammars, Syntactic Analysis, Augmented Grammars and Semantic Analysis, Machine Translation and Speech Recognition. Case Study: Automatic Speech Recognition System. **Case Study I:** Understand the development and deployment of AI Chat Bots.

Question and Answer Problem, Information extraction and Translation, Corpus,

Unit -IV**12 Hours****Robotics and Impact of AI on Human Labor and Social Equity**

Robotics- Robot Hardware- Robot Perception- Planning to Move- Planning Uncertain Movements- Planning Moves- Robotic Software Architectures and Domains. **Impact of AI on Human Labor and**

Social Equity -Benefits on this Technological Revolution- Need and Necessity of Labor based Economy and Society- Distribute future assets more equitably-Support for Unemployed.

Future Impacts of AI, Fault Detection, Diagnosis and Optimization.

Total: 48 Hours

Text Book (s)

1. Russel and Norvig, Artificial Intelligence A Modern Approach, 4th Edition, Pearson Education 2021.
2. StevanFinaly, Artificial Intelligence for Everyone, Relativistic Publications, Great Britan,2020.
3. E. Rich K. Knight and B.Nair – Artificial Intelligence– Third Edition – Tata McGraw Hill, 2017.
4. Jerry Kaplan, Artificial Intelligence- What everyone needs to know, Oxford University Press,2016.

Reference (s)

1. Artificial intelligence: a very short introduction; Margaret A. Boden; Oxford University Press; 2018.
2. Artificial Intelligence and Social Work; MilindTambe, Eric Rice; Cambridge University Press; 2018.
3. Artificial Unintelligence; Meredith Broussard; The MIT Press; 2018.
4. Tom M. Mitchell, –Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam ⁵ (%)
Remember	25	20	-
Understand	35	40	30
Apply	40	40	40
Analyze	-	-	30
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Sample question (s)

Remember

1. Define AI.
2. List any five AI applications.
3. Define a curve matrix.

Understand

1. What is an Expert System??
2. How perception and biometrics differw.r.tAI?
3. Explain confusion matrix with an example

Apply

1. Write a program to convert text to speech.
2. Develop a robot using an AI simulating software.
3. Write a program to demonstrate the working of the expert system to trace its decision.

Analyze

1. Implement a fake product monitoring system using biometrics.
2. Develop and Automatic Attendance Monitoring System.
3. Design and AI BOT to pay Snake game between two players.

Open Book Question(s)

1. MrNeerukonda is a famous real estate agent and always busy with uplift of houses in the nearby villages and small cities. He one day popped with his busy schedule, came into a decision to build a model to predict House prices by taking a coder help called MrTrevedhi, who was a gem in Artificial Intelligence. MrNeerukonda, started off by collecting data on the houses in the areas which he is most interested and nearby too. Assuming that thousands of sample houses data is collected, where each sample contained information on a given house’s properties and handed

over the details to MrTrivedhi. Among these properties include the number of bedrooms, number of bathrooms and square footage. Common sense would lead anyone to believe that there is relationship between the number of bedrooms, the number of bathrooms and the square footage of the house. In other words, anyone can easily suspect that the higher the square footage of a house, the more bedrooms, and bathrooms it contains. If the properties are highly correlated, is it necessary that should we have three individuals for the same underlying property in size, do explain and help MrTrivedhi to resolve this and provide a solution to MrNeerukondasQuery. Apply relevant common-sense reasoning and help MrTrivedhi to determine which of the variables accounts for the most variance in house price, suggesting him an algorithm for solving the same representing with both procedure and pictorial model.

2. Vamsi and Tirumalesh are two best friends, who does all the activities in parallel either in college or in their room. It might depend on various factors like whether or not these two get free from the college on time and able to leave on time, whether they can reach room before 7 pm in the evening depending upon traffic or whether their roommates have some other activity already scheduled that day; in all the cases, their decision to go out to play a game, tennis with their roommates depends mainly upon the particular day and its endure.If everything is fine, and if they are free from college and reach the room in time and if their roommates doesn't have any other class, may want to go out to the tennis court with them. If they reach on time but already has some other activity scheduled that day, they might want to just relax at room, writing the record. Determine and suggest the best algorithm for solving the same.

Course Objectives:

1. Understand the principles of green chemistry and engineering.
2. Familiarize with Environmental green standards
3. Design processes those are benign and environmentally viable.
4. Utilize Nano technological principles for better environment
5. Design processes and products those are safe and hazard free.
6. Modify chemical processes making hazardous products and make them green safe and economically acceptable by using biotechnology.

CO-PO Mapping

CO	PO ₂	PO ₆	PO ₇
1	3	3	3
2	3	3	3
3	3	3	3
4	3	3	3
5	3	3	3
6	3	3	3

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Syllabus**UNIT- I**

Fundamentals of Green Chemistry and Technology- The twelve Principles of Green Chemistry and green engineering with examples Principles of Green Chemistry and technology, green chemistry metrics, atom economy, atom efficiency, E-factor, and other green chemistry metrics.

UNIT- II

Industrial Safety and Hazard analysis- Introduction to ISO standards, hazard identification, life cycle analysis, and safety aspects related to transport, handling and storage of hazardous chemicals. green technologies for addressing the problems of Water, Energy, Health, Agriculture and Biodiversity- WEHAB -eco-restoration- phyto-remediation, ecological sanitation, renewable energy technologies, industrial ecology, agro ecology and other appropriate green technologies , global warming; greenhouse gas emissions, impacts, mitigation and adaptation.

UNIT- III

Green processes- Microwave assisted reactions, ultra-sonication assisted reactions, ionic liquids as solvent, water as a reaction medium, solvent free reactions, supercritical solvents, safe product and process design, case studies Green Nanotechnology – Nanomaterials for water treatment, nanotechnology for renewable energy, nanotechnology for environmental remediation and waste Management, nanotechnology products as potential substitutes for harmful chemicals, environmental concerns with nanotechnology

UNIT- IV

Concept of Cleaner Production, Definition of Cleaner Production, Cleaner Production and End of Pipe Solution, Good House Keeping checklist, tools to be discuss in details with example, Material and Energy Balance of Process, CP Methodology, Barriers and Drivers in cleaner production, Case studies Green Productivity concepts, methodology & techniques, Guidelines of APO on Green Productivity, CEPI Index Emerging technologies and their techno economic evaluation

Text Book (s)

1. Clark, James H., and Duncan J. Macquarrie, eds. Handbook of green chemistry and technology. John Wiley & Sons, 2008.

Reference Book (s)

1. Lancaster, Mike. Green chemistry: an introductory text. Royal society of chemistry, 2020.
2. Lapkin, Alexei, and David Constable. Green chemistry metrics. Wiley, 2008.
3. Manahan, Stanley. Environmental chemistry. CRC press, 2017.
4. Matlack, Albert. Introduction to green chemistry. CRC press, 2010.
5. Anastas, Paul T., and John C. Warner. "Green chemistry." Frontiers 640 (1998): 1998.
6. Dr Bharat Jain, Cleaner Production and its implementation in Industries, GCPC, 2017

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Assignment test (%)
Remember	20	20	10
Understand	40	40	40
Apply	40	40	50
Analyze	--	--	--
Evaluate	--	--	-
Create	--	--	--
Total (%)	100	100	100

Sample Question (s)**Remember**

1. List various benefits of cleaner production.
2. Write the differences between cleaner production and end-of-pipe approach.
3. List the major non-conventional energy resources in India?

Understand

1. Discuss how you identify the opportunities to better assess cleaner production.
2. Write about environmental management hierarchy.
3. Discuss the future need of conventional energy resources.
4. Write the sustainability of geothermal energy in Indian practice.
5. Discuss the strategies in detail how to achieve sustainable development in a country through green technologies.

Apply

1. Explain in detail the factors affecting green technologies.
2. Discuss various barriers of cleaner production process. Also write the processes which do not come under cleaner production.
3. Write the problems, causes and possible solutions for cleaner production Financing.
4. Discuss in details methods for analyzing data and effectiveness in prevention of pollution and achieving cleaner production.
5. Discuss how important to utilize wind based and solar based energy with the associated principles.

21IT015 Human Computer Interaction

3 0 0 3

Course Outcomes

At the end of the course students will be able to

1. Demonstrate the capabilities of both humans and computers from the viewpoint of human information processing.
2. Understand typical human-computer interaction (HCI) models, styles, and various historic HCI paradigms.
3. Understand interactive design process and universal design principles to designing HCI systems
4. Apply HCI design principles, standards and guidelines.
5. Understand user models, user support, socio-organizational issues, and stakeholder requirements of HCI systems
6. Understand HCI issues in groupware, ubiquitous computing, virtual reality, multimedia, and WordWide Web-related environments.

COs – POs Mapping

COs	PO ₁	PO ₇
1	1	3
2	1	3
3	3	1
4	1	2
5	2	3
6	1	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Syllabus

Unit I

12 Hours

Introduction

Importance of user Interface-definition, importance of good design, Benefits of good design, A brief history of Screen design, The graphical user interface-popularity of graphics, the concept of direct manipulation, graphical system, Characteristics, Web user-Interface popularity, characteristics-Principles of user interface.

Design methodologies-participatory design-Usability and tests-Acceptability tests

Unit II

12 Hours

Design process

Human interaction with computers, importance of human characteristics human consideration, Human interaction speeds, understanding business junctions, Screen Designing:-Design goals-Screen planning and purpose, organizing screen elements, ordering of screen data and content-screen navigation and flow- Visually pleasing composition- amount of information-focus and emphasis-presentation information simply and meaningfully-information retrieval on web-statistical graphics-Technological consideration in interface design.

Design Visual thinking-virtual-environments-item presentation sequence-layout-form fill-in dialog boxes

Unit III

12 Hours

Windows

New and Navigation schemes selection of window, selection of devices based and screen based controls, Components-text and messages, Icons and increases-Multimedia, uses problems, choosing colors.

Goals of Co-operation-asynchronous interactions-synchronous distributed-application to education-social uses

Unit IV**12 Hours****Software Tools and Interaction Devices**

Specification methods, interface-Building Tools, Keyboard and function keys, pointing devices-speech recognition digitization and generation-image and video displays-drivers.

Database query and phase search in documents, multimedia document searches, information visualization

Total: 48 Hours**Textbook (s)**

1. Wilbert O Galitz, Wiley Dream Tech, The essential guide to user interface design, 3rd Edition, Wiley Computer Publishing, 2007.
2. Ben Shneidermann, Designing the user interface, 3rd Edition, Pearson Education Asia, 2008.

Reference (s)

1. Alan Dix, Janet Finckay, Gregory, Abowd, Russell Beaulieu, Human Computer Interaction., 3rd Edition Pearson Education, 2004.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	40	40	--
Understand	60	40	80
Apply	--	20	20
Analyze	--	--	--
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Sample**Question****(S)****Remember****er**

1. Define Human Computer Interaction.
2. What is the basic goal of Human Computer Interaction?
3. State the long term goal of HCI
4. List the factors HCI designers must consider for User Interface Design

Understand

1. Demonstrate the HCI importance.
2. Extend the Trouble faced by human with Computers.
3. Illustrate Psychological Responses to Poor Design
4. Interpret Human-factor variables used in Comparison of pointing devices

Apply

1. Identify the amount of Information need to present in a page.
2. Organize the different Software tool specification methods.
3. Model out the six types interaction tasks properties of Pointing devices (For Open Book Examination and not for semester end examination)

21BS006 Handling of Industrial waste and waste water

3 0 0 3

Course Outcomes

1. Understand the procedures for assessment of quality of Industrial water and processes of handling of waste water.
2. Demonstrate the utilization of waste water in industry by adopting different processes.
3. Explain the sampling, preservation and characterization of waste water and its treatment.
4. Understand the discharge of industrial waste water into water bodies and its management.
5. Illustrate the functioning of effluent treatment plants and effluent disposal.
6. Identify the nature of liquid waste coming from different industries and propose the suitable treatment techniques.

COs-POs Mapping

COs	PO1	PO7
1	2	3
2	2	3
3	2	3
4	2	3
5	2	3
6	2	3

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I

Requirement of Quality and Quantity of water to Industry

Process water for industries like Textiles, Food processing, power plants, fertilizers, pharma, Selection of water source based on quality and quantity. Utilization of Municipal wastewater in Industries, waste water treatment- Adsorption, Reverse Osmosis, Ion Exchange, Ultra filtration, Elutriation, Removal of Colour, Odour and Taste.

Waste Water composition in steel industry

11+3 Hours

Unit II

Industrial Wastewater Management

Survey on Industrial waste –evaluation of industrial waste water Flow-generation rates – Sampling of Industrial wastewater and preservation of samples for analysis - characterization of waste water-Toxicity of industrial effluents-Treatment of wastewater, recycling, reuse and recovery of resources.

Proper handling of waste water

12+4 Hours

Unit III

Discharging of Industrial wastewater

Discharges into Streams, Lakes and oceans and associated problems, Land treatment - Common Effluent Treatment Plants: advantages and suitability, Limitations and challenges- Recirculation of Industrial Wastes- Effluent Disposal Method *Discharge levels of toxic contaminants in industrial effluent*

11+4 Hours

Unit IV

Processing and treatment of waste water

Water utilization in manufacturing Process, origin, characteristics, effects and treatment methods of liquid waste from industries like (i) Steel plants (ii) Fertilizers (iii)Textiles (iv) Paper and Pulp industries (v) Pharmaceutical Plants.

Removal of dyes from the industrial waste water

11+4 Hours

Total: 45+15 Hours

Text Book(s)

1. M. N. Rao and A. K. Dutta, "Wastewater Treatment", 3rd Ed., Oxford & IBH Publishing, 2020.
2. K.V. S. G. Murali Krishna, "Rural, Municipal and Industrial Water management", Reem Publications, 2008.
3. Metcalf & Eddy Inc., "Wastewater Engineering: Treatment and reuse", 4th Ed., McGraw Hill Education (India), 2017.

Reference(s)

1. A. D. Patwardhan, "Industrial Wastewater treatment", 2nd Ed., PHI Learning, 2017.
2. G. L. Karia and R.A.Christian, "Wastewater Treatment: Concepts and Design Approach", 2nd Ed., Pentice Hall India Learning Private limited, 2013.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	30	30	--
Understand	50	50	50
Apply	20	20	50
Analyse	--	--	--
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Sample questions(s)**Remember**

1. What is meant by industrial waste water?
2. What is the composition of steel industry waste water?

Understand

1. Explain the treatment methods for generation of liquid waste from textile industry
2. Explain the process of separation of particles from industrial waste by Elutriation method
3. Illustrate the industrial waste discharges into oceans

Apply

1. How the industrial wastes are purified by using effluent plants?
2. Illustrate what measurements are taken in the handling of preservation of different industrial waste samples.
3. Compare the handling of different industrial waste waters

Open Book Exam question

1. In industrial area, one of the industry discharges waste waters, how to identify toxicity of industrial effluents in that water. Suggest and explain the process for that industrial waste water to purification, recycling and reuse

21OE001 Robotics and Automation

3 0 0 3

Course Outcomes

1. Identify different types of robots and their parts using basic robotics and automation concepts
2. Asses the simple robot motion control strategies using kinematics and dynamics principles.
3. Assess the scope of automation in various applications
4. Set up basic feedback control systems in robots
5. Demonstrate different types of sensors and actuators to robotic systems
6. Explore future trends and case studies of robotics and automation in industrial and service sector

COs	PO5	PO6	PO7
1	3	3	2
2	3	3	3
3	3	3	3
4	3	3	3
5	2	3	2
6	3	3	3

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit 1: Introduction to Robotics and Automation

Basics of Robotics Definition and scope of robotics, History and evolution of robotics, Types of robots - industrial, service, mobile robots- Basic components of a robot, Overview of robotic joints and links

Introduction to Automation Definition and scope of automation, Differences between automation and mechanization, Applications of automation in various industries, Advantages of using robots and automation, Current trends and future of robotics and automation **10 Hours**

Unit 2: Robot Kinematics and Trajectory Planning

Robot Kinematics Degrees of freedom (DOF), Forward and inverse kinematics, Introduction to Denavit-Hartenberg (DH) parameters, Basic concepts of dynamics in robotics

Trajectory Planning Path and trajectory planning basics, Joint space vs. Cartesian space trajectories, Introduction to motion control, Basics of control systems - open loop and closed loop, Introduction to advanced control strategies -adaptive and intelligent control **13 Hours**

Unit 3: Sensors and Actuators

Introduction Types of sensors used in robotics -proximity, vision, tactile - Sensor specifications and selection criteria, Basics of sensor integration and signal processing, Types of actuators, Characteristics and applications of different actuators, Basics of actuator control

Sensor and Actuator Interfacing Interfacing techniques for sensors and actuators, Introduction to communication protocols, Basics of microcontrollers and microprocessors in robotics

Feedback Systems- Importance of feedback in robotics, Types of feedback systems, Basics of feedback loop implementation **13 Hours**

Unit 4: Robot Programming and Industrial Applications

Robot Programming: Methods of programming, features of programming, simple programs, Emerging technologies, AI in robotics, collaborative robots, IoT integration

Industrial Applications Overview of industrial robots and automation systems, Case studies of robotic applications in manufacturing- welding, assembly, painting- Introduction to service robots, Basics of mobile robotics **12 Hours**

Text books:

1. John J. Craig, *Introduction to Robotics: Mechanics and Control*, 4th edition Published by Pearson (March 4, 2022) © 2018
2. Kevin M. Lynch and Frank C. Park, *Modern Robotics: Mechanics, Planning, and Control*, Cambridge University Press, 1st Edition, 2017.
3. Tadej Bajd, Miomir Vukobratović, "Introduction to Robotics," Springer, 3rd Edition, 2019.

Reference Books

1. K.S. Fu, R.C. Gonzalez, and C.S.G. Lee, *Robotics: Control, Sensing, Vision, and Intelligence*, McGraw-Hill, 1st Edition, 1987.
2. Mukherjee, S., "Service Robotics," Nova Science Publishers, 1st Edition, 2023.
3. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, "Robot Modeling and Control," Wiley, 2nd Edition, 2020.
4. Bruno Siciliano and Oussama Khatib (Editors), *Handbook of Robotics*, Springer, 2nd Edition, 2016.
5. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, and Nicholas G. Odrey, *Industrial Robotics: Technology, Programming, and Applications*, McGraw-Hill, 1st Edition, 1986.

Sample questions

Remember

1. What are industrial robots typically used for in manufacturing?
2. List two examples of service robots.
3. Identify three emerging technologies in robotics.

Understand

1. Explain the selection criteria for choosing a sensor in a robotic system.
2. Describe the characteristics and applications of electric actuators.
3. Summarize the importance of feedback in robotic systems.
4. Explain the difference between forward and inverse kinematics.
5. Summarize the basics of PID control in motion control systems.

Apply

1. Integrate a proximity sensor with a microcontroller for a robotic application.
2. Design a basic control system for a pneumatic actuator.
3. Implement a feedback loop for a robotic arm using a tactile sensor.

Course Outcomes

1. Abstract the basic concepts of IoT
2. Summarize the structural knowledge of IoT
3. Exemplify M2M in the context of Internet of Things.
4. Infer the IoT Reference Architecture
5. Interpret the Internet of things systems for the given problem
6. Find IoT for various engineering applications

COs – POs Mapping

COs	PO ₁	PO ₂
1	2	-
2	2	2
3	2	2
4	2	-
5	2	2
6	3	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I**Introduction and Fundamental IoT Mechanisms**

What is the Internet of Things? History of IoT, About IoT, Overview and Motivations, Examples of Applications, Internet of Things Definitions and Frameworks, IoT Definitions, IoT Architecture, Identification of IoT Objects and Services, Structural Aspects of the IoT, Environment Characteristics, Traffic Characteristics, Scalability, Interoperability, Security and Privacy..

IOT paradigm-smart objects, Bits an atoms-goal orientation, RTLS+ GPS-agents, Multi agent system

12 Hours**Unit II****M2M to IoT**

A Market Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT–An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

Introduction to Atmega 8 /16 microcontroller, Architecture of the AVR Microcontroller, Pin description of the Microcontroller.

12 Hours**Unit III****IoT Reference Architecture**

Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints-hardware is popular again, Interaction and remote control. Industrial realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things, Commercial Building Automation- Introduction, Case study: phase one commercial building automation today, Case study.

Specification-Domain Model Specification, Information Model Specification, Service Specifications, IoT Level Specification, Functional View.

12 Hours**Unit IV****IoT for Business Applications**

Internet of Things Application: IoT for Smart Grid ,City Automation, Automotive Applications, Home Automation, Smart Cards , Process Monitoring / Automation, Sensor Technology, Raspberry- pi Interface, Smart Healthcare, Smart Transportation, M2M Communication, Smart Metering, Systems and Services Integration, Hands-on training, Smart Waste Management System.

Sharing Sensor Data on Social Networks-Twitter-Facebook Connection App, Updation of Sensor Data on Website /Blog.

12 Hours**Total: 48 Hours**

Textbook (s)

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, 1st Edition, Academic Press, 2014.
2. Daniel Minoli, Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, ISBN: 978-1-118-47347-4, Wiley Publications, 2014.
3. Bernd Scholz-Reiter, Florian Michahelles, Architecting the Internet of Things, ISBN 978-3- 642-19156-5 e-ISBN 978-3-642-19157-2, Springer, 2016.

Reference (s)

1. Parikshit N. Mahalle & Poonam N. Railkar, Identity Management for Internet of Things, River Publishers, ISBN: 978-87-93102-90-3 (Hard Copy), 978-87-93102-91-0 (ebook), 2015.

Sample Question (S)**Internal Assessment Pattern**

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	25	25	--
Understand	75	50	--
Apply	--	25	100
Analyse	--	--	--
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. Write the major significance of Internet of Things.
2. State the crucial requirement of IoT in terms of application and its supporting natures.
3. List the dominant technologies behind IoT development.
4. Identify two major differences between Internet of Everything and Industrial IoT.
5. Write about the data-center based cloud tools that use to run the machine learning algorithm internally.
6. Recognizes an alternative approach that results in better adaptivity in case of network fluctuations and increased latency.

Understand

1. Identify the evolutionary terms of Internet of Things (IoT) that use to interact and live with the physical objects.
2. Illustrate the reference architecture of IoT that unifies the smart objects and human beings to provide the ubiquitous communication
3. Illustrate the service-oriented architecture of IoT that ensures the interoperability among the heterogeneous devices
4. Illustrate the API-Oriented Architecture of IoT that use SOAP and Remote Method Invocation (RMI) as a means for describing, discovering, and calling services
5. Discuss the resource capacity, selecting and provisioning the resources that greatly impact Quality of Service (QoS) of the IoT applications
6. Classify the taxonomy of resource management activities of IoT.

Apply

1. Interpret a study analysis on open-source prototyping platform for the industrial IoT.
2. Implement a suitable OPENIoT Architecture for IoT/Cloud Convergence that provides an abstract presentation of the functional elements of architecture.
3. Sketch W3C SSN-XG ontology and how to semantically enable real time sensor feeds.
4. Execute the two-tier data dissemination model for large-scale wireless sensor network.
5. Demonstrate SPARQL query caching in order to improve the performance of semantic web applications.
6. Illustrations a technique to cluster semantically similar QA pairs for retrieving an answer for a newly given query without asking the QA engine on the cloud side.
7. Design a 4bit binary adder using Finite state machine.

8. Discuss various business applications of IoT such as Smart Grid, City Automation, Automotive Applications, Home Automation, and Smart Healthcare. Explain the role of sensor technology, Raspberry Pi interface, M2M communication, and smart metering in these applications.
[Open Book Examination Question]
9. Describe the transition from Machine-to-Machine (M2M) communication to IoT. Outline the architectural changes, main design principles, and capabilities required for IoT. Compare M2M value chains with IoT value chains and discuss the emerging industrial structure for IoT.

21OE003 Fundamentals of Image processing

3 0 0 3

Course Outcomes

1. Interpret the fundamental concepts of gray and color image processing
2. Infer image transforms
3. Exemplify image enhancement techniques in spatial and frequency domains
4. Illustrate image restoration techniques
5. Summarize line, point, threshold and region based segmentation for digital images
6. Assess various compression models and compression techniques for digital images

COs - POs Mapping

COs	PO1	PO2
1	2	-
2	2	-
3	2	-
4	2	2
5	2	-
6	3	2

3-Strongly linked | 2-Moderately linked| 1-Weakly linked

Unit I

Digital Image Fundamentals

Fundamental steps in digital image processing, Components of an Image processing system, Elements of visual perception, Image sampling and quantization, basic relationships between pixels.

Color fundamentals, Color models, Pseudo color Image Processing, Full Color Image Processing, color transformations.

Color Image Enhancement in spatial and frequency domain

12 Hours

Unit II

Introduction to Image transforms: Two Dimensional Discrete Fourier Transform(2D-DFT) and its properties, Discrete cosine transform(2D-DCT), Discrete Wavelet Transform(2d-DWT).

Image Enhancement

Enhancement in spatial domain: Intensity transformations, Histogram Processing, smoothing and sharpening, Image Enhancement in Frequency Domain: Smoothing and Sharpening Filters

Walsh Transform, Hadamard Transform

12 Hours

Unit III

Image Restoration

Image Degradation/Restoration model, Noise models, Restoration using spatial filtering, Periodic noise reduction by frequency domain filtering, Linear Position-Invariant Degradations, Inverse filtering, Minimum Mean Square Error Filtering, Constrained Least squares filtering.

Estimating the degradation function, Geometric Mean filter

12 Hours

Unit IV

Image Segmentation and Compression

Image segmentation: Fundamentals, point, Line and Edge detection, Thresholding, Region based Segmentation, Image Compression: Fundamentals, Image Compression Models, Lossless Compression, Lossy Compression, Transform coding.

Watershed algorithm, JPEG compression standard

12 Hours
Total: 48 Hours

Textbook (s)

1. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Pearson Education, 3rd Edition 2011
2. S. Sridhar, Digital Image Processing, Oxford publishers, 2nd Edition, 2016

Reference (s)

1. Anil K. Jain, Fundamentals of Digital Image Processing, Pearson Education, 1st Edition, 2015
2. S. Jayaraman, S. Esakirajan, T. Veerakaumar, Digital Image Processing, McGraw Hill publishers, 2011
4. M. Sonka, V. Hlavac, R. Boyle, Image Processing, Analysis and Machine Vision, Vikas Publishing House, 2001

SAMPLE QUESTION (S)**Internal Assessment Pattern**

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Assignment Test (%)
Remember	25	25	--
Understand	75	50	--
Apply	--	25	100
Analyse	--	--	--
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

REMEMBER

1. List the 6 components of digital image processing system
2. Define image enhancement
3. Define image segmentation
4. State the lossy compression
5. List out the 3 color models

UNDERSTAND

1. Interpret the process of image sampling and quantization
2. Summarize the fundamental steps in digital image processing
3. Represent RGB color model
4. Explain the properties of 2D Discrete Fourier Transform
5. Illustrate contrast stretching transformation function to increase the dynamic range of the gray levels in the image

APPLY

1. Consider the image segment shown below. Compute N₄, N₈ distances

3	1	2	1 (q)
2	2	0	2
1	2	1	1
(p) 1	0	1	2

2. Compute histogram equalization for a given 8x8 image
3. Compute the efficiency of Huffman Coding for the given symbols

Symbol	a1	a2	a3	a4	a5	a6
Probability	0.1	0.4	0.06	0.1	0.04	0.3

4. Implement segmentation on given image using bimodal thresholding
5. Show that a linear, spatially -invariant degradation system with additive noise can be modeled in the spatial domain as the convolution of the degradation function with an image followed by addition of noise

Course Outcomes

1. Illustrate various digital data acquisition systems
2. Summarize various data transfer techniques
3. Interpret the working principle of serial interface
4. Summarize the working principle of various digital instruments
5. Interpret various signal condition techniques
6. Assess various Remote data Acquisition techniques

COs – POs Mapping

COs	PO ₁	PO ₂
1	2	-
2	2	2
3	2	2
4	2	2
5	2	-
6	3	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I**Introduction to Data Acquisition systems**

Use of signal conditioners, scanners, signal converters, recorders, display devices, A/D & D/A circuits in digital data acquisition, Instrumentation systems: Types of Instrumentation systems, Components of an analog Instrumentation Data – Acquisition system. Multiplexing systems, difference between TDM and FDM systems, Uses of Data Acquisition Systems, Use of Recorders in Digital systems, Digital Recording systems, Modern Digital Data acquisition system, operation of sample Hold circuits.

sample & hold circuits- specifications and design considerations.

12 Hours

Unit II**Data Transfer Techniques:**

Interfacing To PC: Expansion Buses- ISA Bus, EISA Bus, PCI Bus. Plug in data Acquisition and Control Boards: Functions of Plug in DAQ boards, Design of General purpose DAQ boards, Data Acquisition using Serial Interface: Serial Interface Standards Rs 232, USB-Features of USB, USB Transfer, GPIB/IEEE-488, LAN, Universal serial bus, HART protocol, Zigbee, Bluetooth.

Foundation Field bus, ModBus.

12 Hours

Unit III**Digital Instruments**

Digital voltmeters (DVMs): working principle, construction, operation, salient features, range selection– Ramp type, dual slope integrating type, successive approximation type, Digital Frequency Meter: working principle and its construction using block diagram, frequency ratio meter, Recorders: The working principle, construction, operation and salient features of X-t strip chart recorder, Block diagram of PLC, difference between PLC and PC.

X-Y strip chart recorder and Magnetic type recorder.

12 Hours

Unit IV**Signal Conditioning and DAQ Systems**

Single channel and multichannel, Graphical Interface (GUI) Software for DAS, RTUs, PC-Based data acquisition system, Data logging - applications - Automobile, Aerospace Manufacturing, Environmental monitoring. Temperature Measurement using Thermistor, Thermocouple, Strain Measurement System, Interfacing Light Emitting Diode and Photo sensor, Acceleration Measurement, Function Generator, operation of DC servo meter and its characteristics, Remote data Acquisition using Internet

Machine vision-based inspection system, IC engine data

12 Hours

Total: 48 Hours

Text Books

1. Di Paolo Emilio, Maurizio , “Data Acquisition Systems from Fundamentals to Applied Design”, Springer; 2013.
2. S. Gupta, J.P. Gupta, PC Interfacing for Data Acquisition and Process Control, ISA, 1994, 2nd Edition
3. Bell David A, “Electronic Instrumentation and Measurement”, PHI, Inc, New Delhi (1994).
4. Tocci Ronald J, “Digital Systems Principles and Applications”, PHI, New Delhi (2002)

Reference Books

1. A. D. Helfrick and W.D. Cooper, “Modern Electronic Instrumentation and Measuring Techniques”, Pearson, 1st Edition, 2015.
2. R. K. Jain, “Mechanical & Industrial Measurements”, Khanna pub.
3. Chennakesava R Alavala, “Principles of Industrial Instrumentation and control systems”, Cengage publ.

SAMPLE QUESTION (S)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open book Examination (%)
Remember	25	25	--
Understand	75	50	--
Apply	--	25	100
Analyse	--	--	--
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. List the Converter Characteristics and explain them
2. Discuss the objectives of DAS.

Understand

1. Draw the circuit diagram of Polynomial converter and explain its operation in detail
2. Explain the concept of Digital signal processing system in Digital Acquisition System along with circuit diagram
3. Define Error? Explain the different Error sources present in ADC and DAC systems in detail

Apply

1. Design a digital Voltmeter of range 0 to 20 v
2. Determine the working principal of HART protocol
3. Construct a digital frequency meter
4. Analyze various data loggers
5. Justify the working principal of Machine vision-based inspection system. IC engine data
6. Compare Various Remote data Acquisition using Internet

[Open Book Examination Question]

Course Outcome

1. Demonstrate the overview of aviation industry.
2. Describe the passenger and cargo traffic forecasting principles.
3. Explain the passenger and cargo operations in airports.
4. Describe airside infrastructure operations and maintenances.
5. Outline the operations and maintenance of airfield lighting and safety systems.
6. Optimize airport operations and service quality.

COs-POs Mapping

COs	PO2	PO4	PO11	PO12
1	1	2	3	2
2	1	2	3	2
3	1	2	3	2
4	1	2	3	2
5	1	2	3	2
6	1	2	3	2

3 - Strongly linked | 2 - Moderately linked | 1 - Weakly linked

Unit I

Overview of Aviation Industry

Stakeholders of aviation industry - International organizations - ICAO, IATA, ACI, Regulatory regime- CAA, DGCA,FAA. Airport Master Plans. India’s airports operations and management - ICAO SARPs - Airport capacity and determinants. Passenger traffic and cargo traffic forecasting principles. Definition meaning of terms- Airport classifications.

12 Hours

Unit II

Passenger operations and Cargo Operations

Passenger process flow- Baggage process flow. Planning requirements and spatial requirements. Service level requirements and design inputs. PTB design concepts- Systems description. Cargo – process flow, infra and facilities required, planning parameters

12 Hours

Unit III

Airside Operation

Airfield pavements, types- Runway, Taxiway, Apron. Aircraft movement flow in the airfield - Obstacle Limitation Surfaces (OLS) - Airfield terms and importance- Strip, RESA, TORA,TODA,ASDA, LDA - Visual Aids- Pavement marking, Airfield Ground Lighting systems- System description - Rescue and Fire Fighting - Air Navigation Services Principles- Air Traffic Management, Communication, Navigation and Surveillance (CNS) system, Meteorological services - Safety and security management - Apron services. Apron control.

12 Hours

Unit IV

Operation and Maintenance Management

Typical Organization chart. Regulatory Requirements- Objective and subjective service quality parameters and measurement. Service quality delivery assessment by third parties. Passenger experience - Operational efficiency - Maintenance- maintenance schedules and implementation - Control centres. Emergency planning. Standard Operating Procedures. Contingencies. Incident reports - On Time Performance (OTP) of flights. Operations manual - Certifications, accreditations. Bird, wildlife and hazard management.

12 Hours

Total: 48 Hours

Textbook (s)

1. Airport Planning & Management, Seventh Edition (AVIATION) by Seth Young, Alexander T. Wells, McGraw-Hill Education Publications, 2019.
2. Introduction to Aviation Management by Andreas Wald, Christoph Fay, and Ronald Gleich, Lit Publications, 2012.
3. Airport Systems: Planning, Design, and Management by Richard de Neufville and Amedeo R. Odoni, McGraw-Hill Education Publications, 2013.

Reference (s)

1. Aviation Safety Programs: A Management Handbook by Richard H. Wood and Robert W. Sweginnis, Jeppesen Sanderson publisher, 2003.
2. Global Airport and Aviation Management: Cases in Airport, Airline, and Aerospace Management by C. Daniel Prather
3. Airport Operations by Norman J. Ashford, H.P. Martin Stanton, and Clifton A. Moore, McGraw-Hill Education publications, 2012.
4. Air Transport Management: An International Perspective by Lucy Budd and Stephen Ison, Routledge Publications, 2020.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book/Assignment Exam(%)
Remember	40	40	40
Understand	60	60	60
Apply	--	--	--
Analyze	--	--	--
Evaluate	--	--	-
Create	--	--	--
Total (%)	100	100	100

Sample Question (s)**Remember**

1. What is an Airport Master Plan?
2. What factors determine airport capacity?
3. What are the key stages in the passenger process flow within an airport terminal?
4. Define airside operations.
5. How organizational chart is useful to operation and maintenance.

Understand

1. Explain the importance to have an efficient baggage process flow in an airport terminal.
2. Illustrate service level requirements influence the design of a passenger terminal building (PTB).
3. Explain in details about Obstacle Limitation Surfaces.
4. Describe the concept of on time performance.
5. Infer the importance of safety in aviation.

Course Outcomes

1. Interpret embedded system architecture.
2. Illustrate the Quality Attributes to be optimised during embedded system design.
3. Classify the communication interface of embedded system.
4. Explain the hardware and firmware development.
5. Summarize the embedded target boards.
6. Demonstrate interfacing of sensors, actuators and IO peripherals with embedded boards.

COs - POs Mapping

COs	PO ₁	PO ₂
1	2	2
2	2	2
3	2	2
4	2	2
5	2	2
6	3	2

3-Strongly linked | 2-Moderately linked| 1-Weakly linked

Unit I

Introduction to Embedded Systems

Embedded Systems - Definition, Structure, Characteristics and Examples. Quality Attributes (Non-operational & Operational), Core of Embedded System, Memory: Masked ROM, Programmable ROM, EPROM, EEPROM, Flash, RAM) Microprocessor vs Microcontroller, Harvard and Von-Neumann Architecture, RICS vs CICS Architecture, Little-Endian vs Big-Endian Processor, Classification of Embedded System Based on Generation, Complexity and Performance, Embedded System vs. General Computing System.

Reset Circuit, Watchdog Timer

14 Hours

Unit II

Communication Interfaces

On board communication interfaces: Inter Integrated Circuit (I2C), Serial Peripheral Interface (SPI), Universal Asynchronous Receiver Transmitter (UART). Off board communication interfaces: RS232, Universal Serial Bus (USB), BLUE TOOTH, WIFI, ZigBee.

1-Wire Interface, GPRS

10 Hours

Unit III

Hardware and firmware development

Embedded firmware design approaches and development languages, Embedded C, Fundamental Issues in Hardware and Software Co-Design, Hardware software tradeoffs, Integration of Hardware and Firmware. CAD and hardware Translation tools. Pre-processors, Interpreters, Compilers, Linkers. Debugging tools, Simulators and Laboratory tools. Features of Real-Time Operating System.

Assembler, Features of General Purpose Operating System

11 Hours

Unit IV

Embedded target boards and Interfacing

Embedded target boards: Features of Arduino Board, Raspberry- pi and ESP8266. Sensors: temperature sensor, humidity and temperature sensor, light dependent sensor, touch sensor, ultrasonic sensor, soil moisture sensor. Actuators: DC Motor, Stepper Motor, Motor Driver L293D, Relay. I/O Devices: 7-Segment Display, LCD, Keypad. Interfacing of Embedded target board with sensors, actuators and IO devices.

Smoke detector, Rain detector

13 Hours

Total: 48 Hours

Textbook (s)

1. Shibu .K.V, Introduction to Embedded Systems, 1st Ed, Tata McGraw Hill Education Private Limited, 2009.
2. Yogesh Misra, Programming and Interfacing with Arduino, CRC Press, 1st Edition, 2021

Reference (s)

1. Frank Vahid, Tony D. Givargis, Embedded System Design-A Unified Hardware/Software Introduction, Wiley Publications, 2002
2. Raj Kamal , Embedded Systems, TMS, Second Edition, 2008

Sample Question (S)**Internal Assessment Pattern**

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	15	15	--
Understand	85	60	--
Apply	--	25	100
Analyse	--	--	--
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. Define embedded system.
2. List any three on board and off board communication interfaces.
3. List any two embedded development boards.

Understand

1. Exemplify the SPI protocol for on board communication interface.
2. Exemplify the I2C protocol for on board communication interface.
3. Demonstrate the purpose of compiler and linker in firmware design.
4. Illustrate the different components of Arduino UNO board.
5. Illustrate the working of capacitive touch sensor.

Apply

1. Construct an interfacing diagram of LCD with Arduino board.
2. Construct an interfacing circuit of 220 V ac operated bulb with Arduino board.
3. Interface a temperature sensor with Arduino UNO board.

210E007 Remote Sensing and GIS

3 0 0 3

Course Outcome

1. Understanding the Remote Sensing fundamentals, platforms, and sensors involved in Remote Sensing.
2. Analyze Aerial Photographs
3. Familiar with GIS basics, spatial data analysis and planning of GIS projects.
4. Explore the Web sources for Satellite data products and analyze Satellite data using image processing techniques.
5. Apply Remote Sensing and GIS technologies in real-world scenarios.
6. Understand the advancements in Remote Sensing and GIS technology.

COs-POs Mapping

COs	PO1	PO2	PO5	PO7	PO10
1	3	2	1	1	1
2	3	3	2	1	3
3	3	2	3	2	3
4	3	2	3	2	3
5	3	3	3	3	3
6	3	2	3	2	2

3 - Strongly linked | 2 - Moderately linked | 1 - Weakly linked

Unit I

Basics of Remote Sensing

Electromagnetic Spectrum: wavelength regions important to remote sensing, Reflectance, Transmission, Absorption, Thermal Emissions, Scattering, Elements involved in Remote Sensing, Advantages and Disadvantages of Remote Sensing.

Platforms and Sensors: Types of platforms, orbit types, Sun-synchronous and Geosynchronous, Passive and Active sensors, resolution concept, Indian Remote Sensing Satellites and their features-Indian Space Program.

Photogrammetry: Definition, Types of Aerial photographs, Vertical Photographs - Geometry, Scale, problems on Flying height and scale.

12 Hours

Unit II

Basics of Geographical Information systems

GIS: Definition, Objectives, Components, Data Models and Data Structures, Introduction to DBMS.

Map: Types of Maps, Co-ordinate system, Introduction to Map projections.

Spatial Data Analysis: Buffer and Overlay operations, GIS Project Planning.

12 Hours

Unit III

Satellite Data Analysis

Exploration of web sources of satellite data products-Bhuvan, Basic Elements of Visual image Interpretation, Image classification techniques - Supervised and unsupervised, Vegetation indices, water related indices.

12 Hours

Unit IV

GIS Applications and Advancements

Remote Sensing and GIS Applications: Transportation, Water Resources, Environment, Geology, Emergency Management, Agriculture, Urban planning,

Advances in Remote Sensing and GIS: Introduction to Thermal, Microwave and Hyperspectral Remote Sensing. Introduction to Web and Mobile GIS, Google Earth Engine platform for satellite data processing.

12 Hours

Total: 48 Hours

Textbook (s)

1. Remote Sensing and Geographical Information systems, (4th edition) by M.Anji Reddy B.S. Publications, JNTU Kakinada, 2018.
2. Remote Sensing and GIS, (2nd edition) By Basudeb Bhatta Oxford Higher Education.

Reference (s)

1. Remote Sensing and Image Interpretation, Lillesand T.M & Kiefer R.W., John Wiley and Sons, 2015
2. Elements of Photogrammetry with Application in GIS, Wolf P. R., McGraw Hill International Book Company, Fourth Edition, 2014.
3. Introduction to Geographic Information Systems, 9th Edition, Kang Tsung Chang., Tata McGraw Hill Publishing Company Ltd, New Delhi, 2018.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book/Assignment Exam(%)
Remember	20	20	--
Understand	30	30	--
Apply	50	50	100
Analyze	--	--	--
Evaluate	--	--	-
Create	--	--	--
Total (%)	100	100	100

Sample Question (s)**Remember**

1. What are the wavelength regions important to remote sensing?
2. What are the types of aerial photographs?
3. Define overlay operations in GIS
4. Define GIS.
5. List the basic elements of visual image interpretation.

Understand

1. Explain the geometry of vertical photographs.
2. Explain the resolution concept in remote sensing
3. Compare between data models and data structures in GIS
4. Explain the difference between supervised and unsupervised image classification techniques.
5. Summarise the scientific approach of remote sensing data analysis

Apply

1. Utilize the given data to determine the photo scale of a vertical aerial photograph taken over flat terrain with a 152.4 mm focal-length camera from an altitude of 1830 m above ground.
2. Solve for the maximum scale, minimum scale, and average scale given that the highest terrain (h1), average terrain (havg), and lowest terrain (h2) are 610, 460, and 310 m above mean sea level, respectively. The flying height above mean sea level is 1800 m and the camera focal length is 152.4 mm.
3. Utilize RS and GIS techniques for the preparation of LULC.
4. Construct the flow chart for highway alignment using RS and GIS techniques
5. Apply RS and GIS techniques to evaluate the potential sites for artificial recharge of ground water.

Course Outcomes

- 1.Understand the Limitations in SQL.
- 2.Identify the Concepts and advantages of DDBMS.
- 3.Identify challenges of big data and its existing technologies.
- 4.Use UNIX and HDFS commands.
- 5.Analyze data using Map-Reduce frame work.
- 6.Exemplify Concept of R Programming.

Co - Po Mapping

COs	PO ₁	PO ₇
1	3	1
2	2	1
3	2	1
4	1	1
5	3	1
6	3	1

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Syllabus

Unit I

12 Hours

Concepts of DDBMS-Data Fragmentation; Replication; and allocation techniques for DDBMS; Methods for designing and implementing DDBMS, designing a distributed relational database Architectures for DDBMS; cluster federated, parallel databases and client-server architecture. Introduction to Big Data-Challenges of Conventional Systems, What is Business Analytics, Business Analytics life cycle, Why Big Data Analytics, Defining Big data, characteristics of Big Data(V's), Business Analytics Phases: Data Acquisition- Data cleaning-Data Manipulation-Data Analysis(Statistical and Analytical methods) to make sense of data-Data Visualization.

Query Processing problem; objectives of Query Processing

Unit II

12 Hours

Introduction to NoSQL-Overview, and History of NoSQL, Databases Definition of the Four Types of NoSQL. Database, value of Relational Databases, Getting at Persistent Data, Concurrency, Integration, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, The Emergence of NoSQL, Key points, Comparison of relational databases to new NoSQL stores, MongoDB, Cassandra, HBase, Neo4j use and deployment, Challenges NoSQL approach, key-Value and Document Data Models, Column-Family stores, Aggregate-Oriented Databases

Replication and sharding, MapReduce on databases.

Unit III

12 Hours

Introduction to HADOOP- Hadoop ecosystem components and uses, Hadoop storage: HDFS, Concept of Hadoop Distributed file system, Design of HDFS, Configuration of HDFS. HADOOP MapReduce Hadoop Data Types, Functional-Concept of Mappers, Functional-Concept of Reducers, MapReduce Execution Framework, Partitioners and Combiners, Hadoop Clusters component; Name Node, Secondary Name Node, and Data Node, Data flow (Anatomy of File Write and Read);

Challenges for processing Big Data, RDMS vs HADOOP, Accessing HDFS- CLI (command Line Interface)

Unit IV

12 Hours

Statistics with R Programming-Introduction, How to run R, R Sessions, and Functions, Basic Math, Variables, Data Types, Vectors, Conclusion, Advanced Data Structures, Data Frames, Lists, Matrices, Arrays, Classes. R Programming Structures, Control Statements, Loops, - Looping Over Non-vector Sts, - If-Else, Arithmetic, and Boolean Operators and values, Default Values for Argument, Return

Values, Deciding Whether to call return explicitly- Returning Complex Objects, Functions are Objective, No Pointers in R, Recursion, A Quicksort Implementation-Extended Example: A Binary Search Tree.

Math sums, cumulative sums, and products

Total: 48 Hours

Textbook (s)

1. Distributed Databases: Principles and Systems paperback- 1 Jul 2017 by Stefano ceri, Giuseppe pelagatti, McGraw Hill Edition, ISBN-10: 0070265119, ISBN-13: 978-0070265110, 2017.
2. Tom White "Hadoop: The Definitive Guide "Fourth Edition, O'Reilly Media, 2015

Reference (s)

1. M. Tamer Ozsú and Patrick valduriez, "Prinples of Distributed Database Systems",Springer Science + Business Media, Third Edition, 2011.
2. Zikopoulos, P. Parasuram, K.Deutsch,T. Giles, J. & Corrigan, D.v Harness the Power of Big Data The IBM Big Data Platform. McGraw Hill Professional, 2012.
3. The Art of R Programming, Norman Matloff, Cengage Learning,1st Edition,2011.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	40	45	--
Understand	40	45	60
Apply	20	10	40
Analyze	--	--	
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Sample Question (S)

Remember

- 1.List the Applications of BigData Analytics
- 2.Define Data fragmentation in detail

Understand

- 1.Illustrate Advanced Data structures in R programming?
- 2.Explain the concept of History of NoSQL

Apply

- 1.Apply A Binary Search Tree concept to your data base?

Course Outcomes

1. Understand the fundamentals of security and cryptography.
2. Explain the different attacks and services of security.
3. Make use of cryptography types and techniques.
4. Interpret the functionalities of cyber crime and cyber law.
5. Demonstrates the functionalities of firewalls
6. Explain various non-cryptographic protocol vulnerabilities

CO-PO Mapping

CO	PO3	PO6	PO8
1	2	2	3
2	2	2	3
3	2	1	3
4	2	1	2
5	2	2	3
6	2	2	2

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I**12 Hours**

Introduction: What is Security, Data, Information, Attack, Hacker, Goals of Security, Security concerns in computer, web technology, World Wide Web, Internet, Data Transfer, Society, Banking, etc. Individual in information technology, Models for Network Security, Security Terminologies, CIA Traid, Security Attacks, Security Goals, Methods of Defence, Security Services, Security Mechanisms
Types of Hackers, hacking, network sniffing.

Unit II**12 Hours**

Basics of Cryptography: Introduction to cryptography, Cryptographic functions(Authentication, Nonrepudiation, confidentiality, integrity), Cryptanalysis. Types of Cryptography: Symmetric key and Asymmetric Key Cryptography, Principles of Private and Public Key System, Symmetric Cipher Model, Substitution Techniques, Transportation Techniques, Modes of Operations, Message Integrity, Encryption and Decryption Techniques, Digital Signatures.
Applications of Cryptography, cipher types, steganography

Unit III**12 Hours**

Cyber crime and Cyber law: Classification of cyber crimes, Common cyber crimes, cyber crime targeting computers and mobiles, cyber crime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, zero day and zero click attacks, Reporting of cyber crimes, Remedial and mitigation measures, Legal perspective of cyber crime, IT Act 2000 and its amendments, Cyber crime and offences, Organisations dealing with Cyber crime and Cyber security in India,
Cybercrime vs Computer Crime, Case studies.

Unit IV**12 Hours**

IDS and Firewalls: Intruders, Intrusion Detection, Password Management, Firewalls-Characteristics, Types of Firewalls, Placement of Firewalls, Firewall Configuration, Trusted Systems. **Non-cryptographic protocol Vulnerabilities:** DoS, DDoS, Session Hijacking and Spoofing, Software Vulnerabilities- Phishing, Buffer Overflow.
SQL Injection, Intellectual Property.

Total: 48 Hours**Textbook (s)**

1. William Stallings, Lawrie Brown, Computer Security Principle sand Practice Third Edition,2015
2. Nihad A. Hassan, Rami Hijazi, Digital Privacy and Security Using Windows: A Practical Guide, Apress, 2017
3. William Stallings, "Cryptography And Network Security – Principles and Practices", 7th edition, Pearson Education Limited 2017.

Reference (s)

1. Michael T. Goodrich and Roberto Tamassia, Introduction to Computer Security, Addison Wesley, 2011.
2. Ross Anderson, Security Engineering: A Guide to Building Dependable Distributed, 3rd Edition, John Wiley & Sons Inc, 2021.
3. Kozierok, Charles M. The TCP/IP guide: a comprehensive, illustrated Internet protocols reference, 2005
4. Cyber Crime Impact in the New Millennium, by R. C Mishra , Auther Press. Edition 2010.
5. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd. (First Edition, 2011)
6. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform. (Pearson , 13th November, 2001)
7. Harris, Shon, "CISSP all-in-one exam guide." Sixth edition (2013).
8. OWASP top ten security vulnerabilities: <http://xml.coverpages.org/OWASPTopTen.pdf>

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	30	30	--
Understand	40	40	--
Apply	30	30	50
Analyze	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

SAMPLE QUESTION (S)

Remember

1. Mention any two security attacks
2. List any two goals of security
3. Define Cryptography

Understand

1. Differentiate between asymmetric and symmetric key cryptography
2. How do we achieve authentication?
3. Differentiate between Cyber Crime and Computer Crime.

Apply

1. Implement firewall using iptables command.
2. Can message encryption itself provide measure of authentication?

Open Book Exam Questions

Question 1:

A man named Jones wanted to chat with his girlfriend Goldie. But he can see that all his family is around him and even his girlfriend is also with her parents. So, he thought to send a secret message to his girlfriend. They usually love to meet in the "Central Park". Now Jones wants to send a message to Goldie as "Hi Goldie. How are you. Because you are with your parents, and I am with my parents we cannot speak with each other. But I want to meet you at our favorite place central park tomorrow after your class". Help Jones to convert the message to unreadable format using the key of their favorite place. Also suggest him how would Jones tell Goldie that the letter is originated from Jones only.

Question 2:

You have decided to start a startup after graduation. But you alone cannot be doing this, so you have to ask help from your friends. Suggest what techniques you require and which sort of people you would select so that your company will be a huge success. Explain the techniques clearly to your friends and tell them what they have to do in detail.

Course Outcomes

1. Understand the definition of smart city , features and core infrastructure elements.
2. Understand the Smart Cities Mission in India and Global Context
3. Analyze Smart Technologies and Infrastructure
4. Evaluate Governance and Policy Frameworks
5. Assess the economic, social, and environmental impacts of smart city initiatives
6. Critically analyze and compare global and Indian smart city initiatives and projects through detailed case studies

COs - POs Mappings

COs	PO7	PO12
1	3	1
2	3	1
3	3	1
4	3	1
5	3	1
6	3	1

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I**Introduction to smart cities**

Definition and concept of Smart Cities, History and evolution of urbanization and smart cities, Key components of a smart city ,Global examples of smart cities,Challenges and opportunities in smart city development, Overview of the Smart Cities Mission in India,Goals and objectives of the Indian Smart Cities Mission

Environmental Sustainability Plan for smary cities

12 Hours

Unit II**Technologies and Infrastructure in Smart Cities**

Internet of Things (IoT) and its applications in urban environments, Smart infrastructure (transportation, energy, water management),Smart buildings and sustainable architecture,Role of data analytics and AI in smart cities, Cybersecurity and privacy issues in smart city infrastructures,Technological initiatives under the Indian Smart Cities Mission (e.g., smart grids, smart water management)

Benchmarks for Smart Cities

12 Hours

Unit III**Governance and Policy for Smart Cities**

Policy frameworks for smart city development,Governance models and stakeholder engagement,Public-private partnerships (PPPs),Regulatory and ethical considerations,Financing smart city projects, Implementation framework of the Smart Cities Mission in India, Role of Urban Local Bodies (ULBs) and Special Purpose Vehicles (SPVs)

Smart City Reference Framework

12 Hours

Unit IV**Social and Economic Impacts of Smart Cities**

Impact on urban mobility and transportation, Economic benefits and challenges, Social inclusion and equity, Environmental sustainability, Future trends and innovations in smart cities, Impact assessment of Indian Smart Cities Mission initiatives, Best practices and lessons learned from Indian smart cities with case studies.

Strategic components of Area-based development in the Smart Cities Mission

12 Hours

Total: 48 Hours

Textbook (s)

1. John S. Pipkin, Mark E. La Gory, Judith R. Balu (Editors); "Remaking the city: Social science perspective on urban design"; State University of New York Press, Albany (ISBN: 0-87395-678-8)
2. Smart City on Future Life - Scientific Planning and Construction by Xianyi Li
3. The Age of Intelligent Cities: Smart Environments and Innovation-for-all Strategies (Regions and Cities) by Nicos Komninos

Reference (s)

1. Giffinger, Rudolf; Christian Fertner; Hans Kramar; Robert Kalasek; Nataša Pichler-Milanovic; Evert Meijers (2007). "Smart cities – Ranking of European medium-sized cities". Smart Cities. Vienna: Centre of Regional Science
2. Mission statement & guidelines on Smart City Scheme". Government of India - Ministry of Urban Development [http://smartcities.gov.in/upload/uploadfiles/files/Smart City Guidelines\(1\).pdf](http://smartcities.gov.in/upload/uploadfiles/files/Smart%20City%20Guidelines(1).pdf)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book/Assignment Exam (%)
Remember	30	30	-
Understand	70	70	70
Apply			30
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define smart city.
2. List out any four features of smart cities.
3. Define ITS.
4. Differentiate smart and green concepts.

Understand

1. Explain the core infrastructure elements of smart cities.
2. Describe the key components of smart city infrastructure.
3. Explain the process of water management in smart cities.
4. Illustrate the Implementation framework of the Smart Cities Mission in India.

Apply

1. Identify the challenges in adopting smart transportation initiatives from global smart cities.
2. Suggest the areas of improvement for a chosen case study of smart city in India.
3. Identify the best practices from global smart cities regarding water management.
4. Explain the adaptive role of artificial intelligence for smart city mission.

Course outcomes

1. Explain the properties of nano-materials and their applications in relation to bulk materials
2. Apply various chemical and physical methods for the synthesis of nanomaterials
3. Describe the nano size effect on magnetic, electrical, optical, thermal and mechanical properties
4. Explore the various techniques to fabricate thin films.
5. Illustrate the structural, optical properties and its applications.
6. Review the applications of nanomaterials, especially semiconducting metal oxides for sensing and catalysis.

COs – POs Mapping

COs	PO ₁	PO ₁₂
1	3	1
2	3	1
3	3	1
4	3	1
5	3	1
6	3	1

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit 1: Basics of Nanomaterials

Definition and scope, Historical background, milestones in nanotechnology, properties at the nanoscale: quantum effects, surface area to volume ratio. Types of nanomaterials: 0-D nanoparticles, 1-D nanowires and nanotubes, 3-D bulk structured materials. Effect of particle size on dielectric, optical, thermal and mechanical properties. **(12 hours)**

Unit 2: Synthesis and Characterization of Nanomaterials

Bottom-up approaches: Chemical vapor deposition, hydrothermal process, combustion synthesis and sol get process. Top-down approaches: Grinding, planetary ball milling and comparison of particles. Characterization methods: X-ray diffraction, Atomic force microscopy, scanning electron microscopy, BET surface area analysis and XPS

(10 hours)

Unit 3: Fundamentals of Thin Film Technology

Basics of Thin Films: Definition and importance of thin films, Historical developments, Fundamentals of vacuum, basic definition and pressure regions of vacuum, kinetic theory of gases mean free path. **Deposition Techniques:** Physical Vapor Deposition (PVD): evaporation, DC/RF sputtering, and pulsed laser deposition; Chemical Vapor

Deposition (CVD): molecular beam epitaxy, atomic layer deposition, thermodynamics and kinetics of thin film growth, Nucleation models, Factors affecting thin film growth (substrate effects, temperature, pressure) **(14 hours)**

Unit 4: Characterization of Thin Films and applications:

Thickness measurement techniques (profilometry), Structural characterization (GI-X-ray diffraction, electron microscopy), Electrical and optical characterization (four-point probe, UV-Vis spectroscopy), Applications in microelectronics (integrated circuits, transistors), Applications in optoelectronics (LEDs, solar cells, photodetectors), Protective and decorative coatings, anti-reflection coatings, Flexible and wearable thin films.

Textbook (s)

1. S. K. Kulkarni, Nanotechnology: Principles & Practices, 3rd Ed., Springer, 2015
2. B. S. Murthy, P. Shankar, Baldev Raj, B.B. Rath, Ames Murday, Text book of Nanoscience and Nanotechnology, Springer & Universities Press (India) Pvt. Ltd., 2013.

Reference (s)

1. S. M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009
2. R. Kelsall, I. Hamley, M. Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005
3. G. L. Hornyak, H.F. Tibbals, J. Dutta, J. J. Moore, Introduction to Nanoscience and Nanotechnology CRC Press, 2008
4. J. H. Davies, The Physics of Low Dimensional Semiconductors: An Introduction, Cambridge University Press, 1998

SAMPLE QUESTION (S)

REMEMBERING

1. Define nano structured material
2. List any four applications of nanotechnology
3. State Moore's first law and second law

UNDERSTANDING

1. What is the difference between nano particles and thin films?
2. Describe particle size on optical and electrical properties
3. Explain the sol-gel method of synthesis of nano powders

APPLICATION

1. Explain the principle behind protection of skin from UV radiation by sun screen lotion
2. Show that the surface area to volume ratio increases drastically as particle size comes down from micro to nano size.
3. Assess the fabrication of thin film fabrication with respect to deposition parameters
4. Show how the shape and size can be controlled in the formation of thin films using surfactants

ANALYSIS

1. Compare the bottom up & top-down approaches in preparation of nanomaterials
2. Outline how powder XRD technique can be used for characterization of a nano material
3. Electrical and magnetic properties vary for nano material compared to bulk material. Justify
4. Distinguish nanoparticles and thin films growth mechanism

Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open book exam (%)
Remember	20	20	-
Understand	60	60	-
Apply	20	20	60
Analyze			40
Evaluate	--	-	-
Create	--	-	-
Total (%)	100	100	100

Course Outcomes:

1. Understand the Fundamentals of Cloud Computing
2. Explain the principles of resource management and grasp the economic aspects of cloud computing through Service Level Agreements (SLAs) and cloudonomics.
3. Identify the security challenges in cloud computing and apply strategies for securing cloud marketplaces.
4. Utilize open source and commercial cloud platforms within the cloud ecosystem.
5. Understand Advanced Cloud Technologies including containerization with Docker, green cloud computing, IoT integration, and the role of virtual machine (VM) resource management.
6. Apply theoretical knowledge to real-world scenarios through case studies of commercial cloud platforms like Microsoft Azure and Google Cloud Platform

CO-PO Mapping

CO	PO2	PO3
1	2	2
2	2	2
3	3	2
4	2	2
5	2	3
6	2	2

7. 3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit 1: Comprehensive Overview of Cloud Computing**12 Hours**

Introduction to Cloud Computing: Cloud Computing Overview. **Cloud Computing Architecture and Technologies:** Cloud Computing Architecture – Deployment Models - Cloud Computing Virtualization - Cloud Computing XML Basics - Cloud Computing Web Services, Service-Oriented Architecture. **Service Management in Cloud Computing:** Service Level Agreement - Cloud Economics - Managing Data - Introduction to MapReduce – OpenStack.

Unit 2: Data Management, Resource Management, and Cloud Security**12 Hours**

Data Management in Cloud Computing : Cloud Computing Open Source - Cloud OpenStack - Cloud Computing Case Study with a Commercial Cloud (e.g., Microsoft Azure)- Cloud Computing Case Study - Google Cloud Platform. **Resource Management in Cloud:** SLA (Service Level Agreements)- Cloudonomics – MapReduce - Resource Management. **Cloud Security:** Cloud Computing Security-Security Issues in Collaborative SaaS Cloud - Brokers for Cloud Marketplace.

Unit 3: Open Source and Commercial Clouds, Cloud Simulation, Emerging Trends **12 Hours**

Open Source and Commercial Clouds, Cloud Simulator: Overview of Open Source and Commercial Clouds - Cloud Simulator - Mobile Cloud Computing - Fog Computing. **Research Trends in Cloud**

Computing, Fog Computing: Emerging Trends in Cloud Computing-Introduction to Docker Container - Green Cloud-Sensor Cloud Computing - IoT Cloud. **VM Resource Allocation, Management, and Monitoring:** Resource Management in Virtual Machines (VMs) - Cloud Federation

Unit 4: Advanced Cloud Technologies and Case Studies

12 Hours

Cloud-Fog-Edge Enabled Analytics, VM Migration: Cloud-Fog-Edge Enabled Analytics, Basics of VM Migration and Migration Strategies, Docker Container and Components of Docker Architecture. **Serverless Computing and FaaS Model:** Dew Computing, Serverless Computing. Sustainable Cloud Computing. **Case Studies and Recent Advancements:** Real-world Case Studies, Recent Advancements in Cloud Computing

Total : 48 Hours

Course Link:

https://onlinecourses.nptel.ac.in/noc21_cs14/preview

Reference (s)

1. Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wiley, 2011.
2. Enterprise Cloud Computing - Technology, Architecture, Applications, Gautam Shroff, Cambridge University Press, 2010
3. Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010
4. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley- India,2010

21CSMC2 Ethical Hacking

3 0 0 3

Course Outcomes:

1. understand of the basics of ethical hacking, including the principles of networking, the TCP/IP protocol stack, and IP addressing and routing.
2. utilize security techniques involving information gathering, port scanning with NMAP.
3. understand and apply advanced cybersecurity techniques, including cryptographic hash functions, digital signatures, steganography, biometrics, and network-based attacks.
4. identify various cybersecurity threats such as password cracking, phishing, malware, WiFi hacking, and DoS/DDoS attacks, and apply appropriate countermeasures.
5. Understand Advanced Security Protocols and Tools
6. apply ethical hacking skills and tools in real-world scenarios, including conducting vulnerability scans, exploiting system software, and analyze network traffic for security assessments

CO-PO Mapping

CO	PO1	PO2	PO3
1	2	1	2
2	2	2	3
3	2	1	2
4	2	3	2
5	2	3	2
6	2	2	3

7. 3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit 1: Introduction to Networking and Ethical Hacking Fundamentals

12 Hours

Foundations of Networking and Ethical Hacking: Introduction to Ethical Hacking - Basic Concepts of Networking - TCP/IP Protocol Stack. **Understanding Network Protocols :** IP Addressing and Routing - Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) - IP Subnetting. **Advanced Routing and IP Version 6 :** Routing Protocols - IP Version 6 - Routing Examples

Unit 2: Security Techniques

12 Hours

Information Gathering and NMAP: Information Gathering - Port Scanning Using NMAP - Features of NMAP. **Metasploit Exploitation and Advanced Attacks:** Metasploit Exploiting System Software and Privilege - Metasploit Social Eng Attack - MITM (Man in The middle) Attack. **Basic concepts of cryptography:** Private-key cryptography - Public-key cryptography.

Unit 3: Advanced Cybersecurity and Attack Techniques

12 Hours

Cryptography and Applications: Cryptographic hash functions -Digital signature and certificate – Applications. **Steganography, Biometrics, and Network-Based Attacks:** Steganography – Biometrics - Network Based Attacks - DNS and Email Security. **Cybersecurity Threats and Countermeasures:** Password cracking - Phishing attack – Maloeware - Wifi hacking - Dos and DDos attack.

Unit 4: Advanced Security Protocols and Practical Tools**12 Hours**

Hardware Security and Side Channel Attacks: Elements of Hardware Security - Side Channel Attacks - Physical Unclonable Function - Hardware Trojan. **Web Application Security:** Web Application Vulnerability Scanning - SQL Injection Authentication Bypass - SQL Injection Error Based from Web Application - SQLMAP- Cross Site Scripting - File Upload Vulnerability. **Network Analysis:** The NMAP Tool: A Relook - Network Analysis using Wireshark.

Total : 48 Hours**Course Link:** <https://nptel.ac.in/courses/106105217>**Reference (s)**

1. Hacking: The Art of Exploitation, Jon Erickson, No Starch Press, 2nd Edition, 2008
2. Cryptography and Network Security: Principles and Practice, William Stallings, Pearson Publisher, 7th Edition, 2016.
3. Metasploit: The Penetration Tester's Guide, David Kennedy, Jim O'Gorman, Devon Kearns, and Mati Aharoni, No Starch Press Publisher, 1st Edition, 2011.
4. Applied Cryptography: Protocols, Algorithms, and Source Code in C, Bruce Schneier, John Wiley & Sons Publisher, 2nd Edition, 1996.
5. Security Engineering: A Guide to Building Dependable Distributed Systems, Ross Anderson, Wiley Publisher, 3rd Edition, 2020.
6. Practical Packet Analysis: Using Wireshark to Solve Real-World Network Problems, Chris Sanders, No Starch Press Publisher, 3rd Edition, 2017.

21CSMC3 Fundamentals of Web Development

4 0 0 4

Course Objectives:

1. Understand the evolution of the World Wide Web and the essential components of web browsers.
2. Demonstrate proficiency in creating and structuring web content using HTML.
3. Design interactive web forms and implement them into webpages, and apply page layout techniques such as resume formatting.
4. Apply Cascading Style Sheets (CSS) to enhance the presentation and layout of web content
5. Develop responsive and visually appealing website layouts through the integration of CSS techniques.
6. Acquire foundational knowledge in client-side scripting for dynamic web content.

CO-PO Mapping

CO	PO2	PO3	PO5
1	2	1	2
2	2	2	3
3	3	3	2
4	1	2	2
5	1	3	2
6	1	2	2

8. 3-Strongly linked | 2-Moderately linked | 1-Weakly linked

UNIT-I

15 Hours

Internet Structures and an Introduction to HTML: History of the Web, The Tools of Internet Publishing, Browsers and Web Addresses, HTTP Requests, Meet Our Three Languages, The Basics of HTML HTML: HTML Elements (Inline vs. Box), and HTML Lists, UTF8 Characters, HTML Links and Images, HTML Tables

UNIT-II

15 Hours

HTML Forms: Website Navigation (Simple HTML), HTML Forms, Page Layout: Resumes

Introduction to CSS: How CSS Talks to HTML, CSS Declarations, The Box Model, Box Sizing, CSS Resets

Unit-III

15 Hours

CSS Floats and Positions: Introduction, CSS Fonts, CSS Floats, CSS Positions, Horizontal Navigation, Centered navigation

Website Layouts and Design: Standard Website Layouts, Responsive Design, CSS Transitions, Transformations, and Animations, CSS Pseudo-selectors, Full-site Demonstration

Unit-IV

15 Hours

Introduction to Javascript: The Basics of JavaScript (JS), JS Language Features and Syntax, Google Maps API (Application Programming Interface), JavaScript Objects, Event Handling, and DOM (Document Object Model)

JQuery and Frameworks: JQuery Introduction to JQuery, Box Sliders

Total: 60 Hours

Course Link:

<https://www.coursera.org/programs/faculty-development-program-biaop/learn/illinois-tech-fundamentals-of-web-development?source=search#modules>

Text Book(s)

1. Programming the World Wide Web, 8th edition Robert W. Sebesta, Pearson.
2. Web Coding Development All In One for Dummies, Paul McFedries, Wiley.
3. Bootstrap: Responsive Web Development, 1st Edition, Jake Spurlock foreword by Dave Winier, O'Reilly publications.
4. Advanced JavaScript Speed up web development with powerful and benefits of JavaScript, Zachary Shute, Packt Publishers.

Reference(s):

1. Web programming with HTML, XHTML and CSS, 2e, Jon Duckett, Wiley India
2. Web programming Bai, Michael Ekedahl, CENAGE Learning, India edition.
3. An Introduction to Web Design + Programming, Paul S.Wang, India Edition
4. Flask Web Development 2e Miquel Grinberg O'Reilly publications.

21OE012 Business Intelligence & Analytics

3 0 0 3

Course Outcomes:

1. Explain the fundamental concepts of Business Intelligence and Analytics.
2. Analyze and apply the technical architecture of Business Intelligence, data management fundamentals, and database design processes.
3. Utilize descriptive analytics and visualization techniques to analyze data, perform survival analysis.
4. Implement data mining processes and statistical learning techniques.
5. Apply clustering algorithms to perform cluster analysis, segmentation, profiling, and interpretation of actionable insights.
6. Develop and implement machine learning models, neural networks, and text mining processes.

CO-PO Mapping

CO	PO2	PO3	PO5
1	2	1	2
2	2	2	3
3	3	1	2
4	1	2	2
5	1	3	2
6	1	2	2

9. 3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I: Introduction to Business Intelligence and Analytics (BIA)

12 Hours

Introduction to Business Intelligence & Analytics (BIA): Introduction to Business Intelligence & Analytics (BIA)- Drivers of BIA-Types of Analytics: Descriptive to Prescriptive-Vocabulary of Business Analytics-Course Plan and Resources. **Technical Architecture of BIA-** Case Analysis of AT&T Long Distance - Fundamentals of Data Management - OnLine Transaction Processing (OLTP) -Design Process of Databases. **Relational Databases and Data Warehousing :** Relational Databases – Normalisation-SQL Queries-ShopSense Case of Management Questions-Data Warehousing-OnLine Analytical Processing (OLAP)-Data Cube

Unit II: Descriptive and Predictive Analytics

12 Hours

Descriptive Analytics and Visualization: Descriptive Analytics and Visualization-Customer Analytics-Survival Analysis-Customer Lifetime Value-Case Study. **Data Mining and Statistical Learning:** Data Mining Process-Introduction to Statistical Learning-Data Pre-processing-Data Quality-Overview of Data Mining Techniques-Case Study using Regression Analysis. Introduction to Classification -Classification Techniques-Scoring Models-Classifer Performance-ROC and PR Curves . **Classification Techniques and Decision Trees:** Introduction to Decision Trees-Tree Induction-Measures of Purity-Tree Algorithms-Pruning-Ensemble Methods.

Unit III: Advanced Data Mining and Clustering

12 Hours

Tree Implementation in Python: Problem of Targeted Mailing - **Cluster Analysis and Techniques:** Cluster Analysis - Measures of Distance - Clustering Algorithms - K-means and Other Techniques - Cluster Quality - **Case Study and Practical Applications:** A Store Segmentation Case Study using Clustering - Implementation in Python - Profiling Clusters - Cluster Interpretation and Actionable Insights - RFM Sub-segmentation for Customer Loyalty

Unit IV: Machine Learning, Neural Networks, and Text Mining

12 Hours

Machine Learning and Neural Networks: Machine Learning-Artificial Neural Networks (ANN)-Topology and Training Algorithms-Back Propagation-Financial Time Series Modelling using ANN-Implementation in Python - **Text Mining:** Text Mining-Process and Key Concepts-Sentiment Scoring-Text Mining using R: The Case of a Movie Discussion Forum.

Total : 48 Hours

Course Link: https://onlinecourses.nptel.ac.in/noc24_cs65/preview

Reference (s)

1. Data Mining Concepts and Techniques, Han, J., Pei, J., & Tong, H., Elsevier, 4th Edition, 2023.
2. An Introduction to Statistical Learning with Applications in R, James, G., Witten, D., Hastie, T., & Tibshirani, R., Springer, 1st Edition, 2013..

Data sources

1. Adventure Works Cycles", SQL Server sample database
2. "Retail Sense transaction data", real life data of a fashion retailer
3. UCI Machine Learning Repository, <http://archive.ics.uci.edu/ml/>
4. Financial/capital market data: Yahoo! Finance
5. Text data: www.twitter.com
6. ISL resources: <http://www-bcf.usc.edu/~gareth/isl/>
7. Kaggle: www.kaggle.com

210E013 Introduction to Industry 4.0 And Industrial Internet Of Things

3 0 0 3

Course Outcomes:

1. Understand the foundational concepts of Industry 4.0.
2. Evaluate advanced Industry 4.0 technologies and their integration into modern systems.
3. Comprehend cybersecurity principles and the basics of Industrial IoT.
4. Design and implement architectures for Industrial IoT, focusing on business models, reference frameworks, and various layers of IIoT.
5. Utilize big data analytics, software-defined networks, and security measures in Industrial IoT environments.
6. Analyze application domains and evaluate real-world case studies to understand the practical implementation and impact of Industrial IoT.

CO-PO Mapping

CO	PO2	PO3
1	2	3
2	2	2
3	3	3
4	1	2
5	1	3
6	1	2

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I: Introduction to Industry 4.0 and Basics of IoT

12 Hours

Introduction: Sensing & Actuation- Communication - Networking . **Industry 4.0 Fundamentals:** Globalization and Emerging Issues-The Fourth Revolution-LEAN Production Systems-Smart and Connected Business Perspective-Smart Factories. **Advanced Industry 4.0 Technologies:-**Cyber Physical Systems and Next Generation Sensors-Collaborative Platform and Product Lifecycle Management-Augmented Reality and Virtual Reality-Artificial Intelligence-Big Data and Advanced Analysis. **Cybersecurity and Industrial IoT Basics :** Cybersecurity in Industry 4.0 - Basics of Industrial IoT -Industrial Processes -Industrial Sensing & Actuation -Industrial Internet Systems

Unit II: Industrial IoT Architecture and Layers

12 Hours

IIoT Introduction and Business Models: IIoT Introduction-Industrial IoT Business Model and Reference Architecture-Business Models - Reference Architecture. **IIoT Layers - Sensing and Processing-**IIoT Sensing -IIoT Processing -IIoT Communication. **IIoT Layers - Communication and Networking:**IIoT Communication -IIoT Networking .

Unit III: Big Data Analytics and Security in IIoT

12 Hours

Big Data Analytics and Software Defined Networks: IIoT Analytics – Introduction-Machine Learning and Data Science -R and Julia Programming-Data Management with Hadoop. **SDN and Security in IIoT:** SDN in IIoT - Data Center Networks- Cloud Computing in IIoT. **Fog Computing and**

IIoT Security :Fog Computing in IIoT-Security in IIoT -IIoT Application Domains: Factories and Assembly Line, Food Industry.

Unit IV: Application Domains and Case Studies in IIoT

12 Hours

IIoT Application Domains:Healthcare-Power Plants-Inventory Management & Quality Control-Plant Safety and Security (Including AR and VR safety applications)-Facility Management. **IIoT Application Domains and Case Studies:**Oil, Chemical, and Pharmaceutical Industry-Applications of UAVs in Industries-Real Case Studies: Milk Processing and Packaging Industries, Manufacturing Industries, Student Projects ,Virtual Reality Lab, Steel Technology Lab.

Total : 48 Hours

Course Link: <https://nptel.ac.in/courses/106105195>

Reference (s)

1. Industry 4.0: The Industrial Internet of Things, Alasdair Gilchrist, Apress, 1st Edition, 2016.
2. Industrial Internet of Things: Cybermanufacturing Systems, Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, Springer, 1st Edition, 2017.
3. The Fourth Industrial Revolution, Klaus Schwab, Crown Business, 1st Edition, 2017.
4. Smart Manufacturing: The Lean Six Sigma Way, Anthony Tarantino, Wiley, 1st Edition, 2018.
5. Big Data Analytics for Internet of Things, Tausifa Jan Saleem, CRC Press, 1st Edition, 2019.

210E014 Natural Language Processing

3 0 0 3

Course Outcomes:

1. Explain the basic concepts and techniques of Natural Language Processing.
2. Apply advanced smoothing techniques for language modeling and perform Part-of-Speech tagging.
3. apply various parsing techniques including MaxEnt and CRF for sequential tagging, as well as constituency and dependency parsing.
4. Comprehend concepts of distributional and lexical semantics, and perform topic modeling.
5. Implement Information Extraction Techniques
6. Analyze techniques for sentiment analysis and opinion mining, understanding their applications in real-world scenarios.

CO-PO Mapping

CO	PO2	PO3
1	2	1
2	2	2
3	3	1
4	2	2
5	2	3
6	2	2

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I: Foundations of Natural Language Processing

12 Hours

Introduction and Basic Text Processing : Introduction to NLP - Basic Text Processing Techniques. Spelling Correction and Language Modeling: Spelling Correction Methods - Introduction to Language Modeling. Advanced Smoothing and POS Tagging: Advanced Smoothing Techniques for Language Modeling - Part-of-Speech (POS) Tagging.

Unit II: Parsing and Syntax

12 Hours

Models for Sequential Tagging: MaxEnt and CRF.Syntax and Constituency Parsing: Introduction to Syntax - Constituency Parsing Techniques. Dependency Parsing: Fundamentals of Dependency Parsing - Techniques and Applications of Dependency Parsing.

Unit III: Semantic Analysis

12 Hours

Distributional Semantics: Introduction to Distributional Semantics- Techniques and Applications of Distributional Semantics. Lexical Semantics: Introduction to Lexical Semantics- Techniques and Applications of Lexical Semantics.Topic Models: Introduction to Topic Modeling-Techniques and Applications of Topic Modeling-Week 10:

Unit IV: Information Extraction and Advanced Applications

12 Hours

Entity Linking and Information Extraction-Fundamentals of Entity Linking-Techniques and Applications of Information Extraction. Text Summarization and Classification:Techniques for Text Summarization-Methods for Text ClassificationSentiment Analysis and Opinion Mining: Introduction to Sentiment Analysis - Techniques and Applications of Opinion Mining.

Total : 48 Hours

Course Link: https://onlinecourses.nptel.ac.in/noc23_cs45/preview

Reference (s)

1. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Dan Jurafsky and James Martin, Prentice Hall, Second Edition, 2009.
2. Foundations of Statistical Natural Language Processing, Chris Manning and Hinrich Schütze, MIT Press, Cambridge, MA, May 1999.9.

210E015 Affective Computing

Course Outcomes

3 0 0 3

At the end of the course, Student will be able to

1. Understand the fundamentals of affective computing and its applications.
2. Explain emotion psychology and facial expression recognition.
3. Understand speech in affective computing.
4. Understand emotions via heart rate, cardiac parameter, skin conductance together with multimodal analysis.
5. Understand empathy and empathetic agent.
6. Understand the emotionally intelligent machines, types of empathy and its factors.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4
1	3	2	2	3
2	3	3	3	3
3	3	3	3	3
4	3	3	3	3
5	3	3	2	3
6	3	3	2	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit-1

Introduction to Affective Computing

12 hours

Fundamentals of affective computing and its applications, Emotion psychology, Emotion Theory, Brain & Asymmetry, Emotional design, Affect Elicitation, Experimental Methodology.

Unit-2

12 hours

Emotion Recognition

Introduction to Facial Expression Recognition(FER), Facial Feature Extraction, Group Level Emotion, applications of FER, Speech in Affective Computing, Analysis and Synthesis of Affective Speech, Text in Affective Computing, Features and Methods for Text Analysis.

Unit-3

12 hours

Physiological Signals and Multimodal Emotion Recognition

Heart rate and its measurement, Emotion and psychology, cardiac parameters, Emotions via Skin Conductance, Emotions Via EEG, Multimodal Affect Recognition, Multimodal Analysis, Anthropomorphic design.

Empathy and Empathetic agents- Development of Artificial Empathy, Evoking Empathy, Empathy in Virtual and Robotic Agents, Empathy Beyond Emotional States, Evaluation of Empathetic Response, Development of artificial empathy, Evoking empathy, Empathy in robots.

Unit-4

12 hours

Developing Emotionally Intelligent Machines

Emotionally Intelligent Machines part-1- Relevant affective states, Affective auto tutor, Gaze tutor, accuracy in gaze tutor

Emotionally intelligent machines part-2-sensorlite and its performance measures, accuracy and adaption

Empathy and its types, factors

Emotional virtual personal assistance, motivation and challenges, Methods and techniques, ethical concerns of affective computing, privacy concerns Affect sensing concerns, Ethical considerations, Anticipatory mobile computing, AI system perspective, Facial expressions, open issues

Total: 48 Hours

Course Link: <https://onlinecourses.nptel.ac.in/>

Reference(s)

1. Affective Computing, MIT Press
2. The Oxford Handbook of Affective Computing, Oxford University Press
3. The Encyclopedia of Human-Computer Interaction, 2nd Ed.
4. Interaction Design: Beyond Human-Computer Interaction, 2019. (5th Edition) by Jenny Preece, Helen Sharp, Yvonne Rogers (Wiley)

Course Outcomes

1. Understand the key steps and pipeline of Data Science and its application in solving real-world problems.
2. Understand the importance of measuring similarity and dissimilarity between features in data for various analysis tasks.
3. Explain the significance of pre-processing techniques in preparing data for analysis in real-time scenarios.
4. Identify the characteristics and practical applications of different regression models used in real-world scenarios.
5. Apply classification models using appropriate metrics, including the confusion matrix, to assess model performance and make informed decisions.
6. Understand the principles of ensemble modeling and clustering and apply appropriate ensemble techniques to improve the accuracy and reliability of machine learning models.

COs-POs Mapping

COs	PO1	PO2
1	3	3
2	3	3
3	3	3
4	3	2
5	3	2
6	3	2

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

UNIT-I**12 hours**

Introduction: Relation among AI, ML, and Data Science, Importance of Data Science; Data Science Process.

Data Exploration: Objectives of Data Exploration, Forms of Data -Structured, Semi Structured, Unstructured, Datasets-data objects and types of attributes/fields, Characteristics of Datasets and corresponding Statistical Measures.

Data Visualization: Univariate Visualization, Multivariate Visualization.

Categorization of Data Science Algorithms,

UNIT-II**12 hours**

Data Similarity/Dissimilarity: Data Matrix, Dissimilarity Matrix, Proximity/Similarity Measures for various types of data- nominal data, ordinal data, binary data and numerical data, Cosine Similarity.

Data Preprocessing: Data Preprocessing Pipeline, Preprocessing techniques for Cleaning Data, Data Integration, Data Reduction, Data Transformation and Discretization.

Distance-based similarity-Euclidean distance, Jaccard Similarity.

UNIT-III**12 hours**

Regression: Linear Regression, Logistic Regression, and Regularization techniques for improving model performance.

Classification: Classification Principles, Classification Model Evaluation Metrics-Confusion Matrix, Classification using Decision Trees, Distance based Classifier- KNN, Bayesian classifier.

Regression vs classification.

UNIT-IV**12 hours**

Ensemble Learning: Conditions for Ensemble Modeling, Overview of ensemble techniques-Voting, Bagging, Boosting and Random Forest.

Clustering: Clustering Principles, Applications and Purpose of Clustering, Types of Clustering, Clustering Algorithms K-Means clustering, Agglomerative clustering, Divisive clustering.

Applications of clustering, Purpose of Ensemble Learning.

Total: 48 Hours**Textbooks:**

1. Vijay Kotu&Bala Deshpande, "Data Science: Concepts and Practice", 2ndEdition, Morgan KaufmannPublication, 2017.
2. JIaweiHan&MichelineKamber,"DataMining:ConceptsandTechniques",3rdEdition,MorganKaufmannPublishers,2012.
3. Pang-NingTanetal., "IntroductiontoDataMining",2ndEdition,PearsonPublications,2019.

References:

1. Vijay Kotu & Bala Deshpande, "Data Science: Concepts and Practice", 2ndEdition, Morgan Kaufmann Publication, 2017.
2. TomM.Mitchell,"MachineLearning",TataMcGrawHill,1997.
3. SunilaGollapudi,"PracticalMachineLearning"FirstEdition2016,PacktPublishingLtd.

Internal Assessment Pattern

CognitiveLevel	Int.Test1(%)	Int.Test2(%)	OpenbookTest ¹ (%)
Remember	20	20	--
Understand	50	30	--
Apply	30	30	80
Analyze	--	20	20
Evaluate	--	--	--
Create	--	--	--
Total(%)	100	100	100

SAMPLEQUESTION(S)**Remember**

1. What are the different forms of data in data science? Provide examples for each form.
2. Name the statistical measures used to analyze datasets in data science.

Understand

1. Why is pre-processing important in machine learning? Explain with relevant examples
2. What is the difference between supervised and unsupervised algorithms? Provide an example for each type.

Apply.

1. Imagine you have a dataset containing information about houses. How would you handle the following scenarios using pre-processing techniques:
 - a. **Data Cleaning:** How would you deal with missing values in the dataset? What approach would you take to handle outliers or inconsistent data?
 - b. **Data Integration:** Suppose you have additional datasets with relevant information about houses, such as neighborhood demographics or school ratings. How would you combine this information with the existing dataset?
 - c. **Data Reduction:** The dataset contains numerous features. How would you simplify the dataset by reducing the number of features without losing important information?
 - d. **Data Transformation and Discretization:** How would you standardize numerical features in the dataset? Additionally, how would you convert continuous variables, such as house prices, into categorical variables for analysis purposes?

Open Book Question(s)

1. Discuss the importance of data visualization in data science. Provide examples of univariate and multivariate visualizations, and explain how they can be used to gain insights from complex datasets. Support your answer with relevant illustrations or diagrams.
2. Compare and contrast supervised and unsupervised learning algorithms. Provide a detailed explanation of each type, including their characteristics, applications, and differences in the training process. Give an example scenario where you would use each type of algorithm.
3. Assume you have been given a dataset with various features related to customer demographics and their purchasing behavior. Design a data science pipeline to address the following tasks:
 - a. Data exploration and statistical analysis of the dataset.
 - b. Preprocessing steps, including handling missing values, data cleaning, and feature transformation.
 - c. Applying a suitable regression model to predict customer spending based on the available features.
 - d. Evaluating the performance of the regression model using appropriate evaluation metrics.

210E017 Data Structure and Algorithms using Java

Course Outcomes

3 0 0 3

At the end of the course, Student will be able to

1. Demonstrate and apply knowledge of 1D and 2D arrays, lists, vectors, and linked lists using Java.
2. Design and implement stack and queue data structures in Java and apply those to solve problems.
3. Analyse the properties, representations, and operations of binary trees and implement them using Java.
4. Illustrate graph structures, their representation, and related operations, and implement graph data structures using Java.
5. Apply searching, sorting, greedy, and shortest-path algorithms to solve computational problems, and implement these algorithms in Java.
6. Evaluate the efficiency of various greedy.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO12
1	3	2	2	2	3	2
2	3	3	3	2	3	2
3	3	3	3	3	3	2
4	3	3	3	3	3	2
5	3	3	3	3	3	2
6	3	3	3	3	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit-1

12 hours

Introduction

1D array, list and vector, 2D matrices and tables of objects, Java implementation of 1D and 2D arrays and their operations, linked lists and their various operations, stack and queue.

Unit-2

12 hours

Linked Lists and Trees

Java implementation of linked lists, stack and queue, Binary trees: Representation and operations. Variations of binary tree: Binary search tree, Height balanced search tree, Heap tree, Java implementation of binary trees and its variations.

Unit-3

12 hours

Graphs

Graph: Structure, representation and operations, Java implementations of graph data structures, **Algorithms (Part-I)**: Searching and sorting algorithms, Java implementation of Part-I algorithms

Unit-4

12 hours

Algorithms (Part-II): Greedy algorithms, shortest path algorithms, Java implementation of Part-II algorithms

Total: 48 Hours

Course Link: <https://nptel.ac.in/courses/106105225>

Reference(s)

1. Classic Data Structures (2nd Edition) ,Debasis Samanta, Prentice Hall India
2. Java: The Complete Reference, Hebert Schildt, Mc Graw Hill
3. Object-Oriented Programming with C++ and Java, Debasis Samanta, Prentice Hall India
4. Swayam-NPTEL online course entitles “Programming in Java”, Debasis Samanta

210E018 The Joy of Computing Using Python

Course Outcomes

3 0 0 3

At the end of the course, Student will be able to

1. Explain and illustrate foundational computing concepts such as variables, expressions, loops, conditionals, lists, and tuples, and their role in problem-solving.
2. Solve real-world problems like probability analysis, finding duplicates, language translation, and currency conversion using algorithms.
3. Develop and implement algorithms for sorting, searching, and substitution cipher problems.
4. Analyse data from social media platforms and games to derive insights using techniques like sentiment analysis and text processing.
5. Apply problem-solving strategies to real-world scenarios, including pattern recognition, permutations, and area calculations, fostering logical reasoning.
6. Design solutions for case studies like image processing, recursive problems, games, and complex systems such as PageRank.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO12
1	3	3	2	2	2	2
2	3	3	3	2	2	2
3	3	3	2	3	3	3
4	3	3	3	2	2	3
5	3	3	3	3	3	3
6	3	3	3	3	3	3

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit-1

Introduction to Computing

12 hours

Motivation for Computing, Introduction to Programming, Variables and Expressions: Design your own calculator, Loops and Conditionals: Hopscotch once again, Lists, Tuples and Conditionals: Let's go on a trip.

Abstraction Everywhere: Apps in your phone, Counting Candies: Crowd to the rescue,

Unit-2

Sorting and Searching

12 hours

Birthday Paradox, Find your twin, Google Translate: Speak in any Language, Currency Converter: Count your foreign trip Expenses, Sorting: Arrange the books, Searching: Find in seconds, Substitution Cipher: What's the secret!!

Unit-3

Sentiment Analysis

12 hours

Analyse your Facebook data, 20 questions game: I can read your mind, Permutations: Jumbled Words, Spot the similarities: Dobble game, Count the words: Hundreds, Thousands or Millions, Rock, Paper and Scissor: Cheating not allowed!!, Lie detector: No lies, only TRUTH, Calculation of the Area: Don't measure.

Unit-4**12 hours****Case Studies**

Six degrees of separation: Meet your favourites, Image Processing: Fun with images, Tic tac toe: Let's play Snakes and Ladders: Down the memory lane., Recursion: Tower of Hanoi, Page Rank: How Google Works!!

Total: 48 HoursCourse Link: <https://nptel.ac.in/courses/106106182>**Reference(s)**

1. "Learn Python the Hard Way", by Zed A. Shaw.
2. "Think Python: How to Think Like a Computer Scientist", by Allen B. Downey.
3. "Fluent Python: Clear, Concise, and Effective Programming" by Luciano Ramalho.

210E019 Programming in Modern C++

3 0 0 3

Course Outcomes

At the end of the course, Student will be able to

1. Develop C++ programs by applying the fundamental concepts of data structures, memory management, and programming constructs such as loops, arrays, pointers, and references.
2. Analyze object-oriented programming (OOP) features in C++ such as inheritance, polymorphism, and encapsulation to design reusable and efficient solutions.
3. Design programs using advanced OOP concepts like operator overloading, friend classes, and abstract base classes for complex problem-solving.
4. Evaluate error-handling mechanisms in C and C++ using exceptions, templates, and file-handling techniques to ensure robust application development.
5. Investigate modern C++ features like Rvalue references, move semantics, lambda expressions, and smart pointers to develop efficient and concurrent programs.
6. Implement solutions that integrate generic programming principles using the standard library, templates, and modern C++ features for enhanced software development practices.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO12
1	3	2	-	-	2	1
2	3	3	2	2	-	1
3	3	2	3	-	2	1
4	3	3	-	3	2	1
5	3	3	2	3	3	1
6	3	2	3	2	3	1

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit-1

Introduction

12 hours

IO & Loop, Arrays and Strings, Stack and Common Data structures/ Containers, How to build a C/C++ program? Part-I Constants and Inline functions, Reference & Pointer, Default Parameters & Function Overloading, Operator Overloading, Dynamic Memory Management, How to build a C++ program? Part-II, Copy constructor and copy assignment operator, How to build a C++ program? Part - III.

Unit-2

12 hours

OOP in C++

Friend function and friend class, Overloading operator for User – Defined Types: Part 1, Part2, Name space, how to build a C++ program? Part- III Static and dynamic library, Inheritance- semantics, Data Member & Member function – Override & Overload, Constructor & Destructor- Object Lifetime, Phone Hierarchy, Private and protected inheritance, Polymorphism – Type casting, Static and Dynamic Binding, Abstract Base class, Staff salary processing using C, Staff salary processing using C++,

Unit-3

12 hours

Type Casting

Virtual function table, Type casting & Cast operators Part-I, Type casting & Cast operators Part-II, Type casting & Cast operators Part-III, Multiple Inheritance, Exceptions- Error handling in C, Error handling in C++, Function template, Class template, Function objects, Input Output – File handling in C, Streams in C++, Standard Library(Generic Programming)Part-I, Part-II, Part-III.

Unit-4**12 hours****Modern C++**

C++11 and beyond General features, Rvalue and Move/1, Rvalue and Move/2, Rvalue and Move semantics, Rvalue & perfect forwarding, Lambda in C++, Class features, Non-class types and Template features, Compatibility of C and C++ - Significant features, Resource management by Smart Pointers, C++11 and beyond- Concurrency, Closing Comments.

Total: 48 HoursCourse Link: <https://nptel.ac.in/courses/106105234>**Reference(s):****Online Material:**

1. C++ reference - C++98 and C++03, C++11, C++14.
2. Overview of the New C++ (C++11/14) by Scott Meyers, 2015.
3. ISO C++ Standards.
4. Presentations used in the Course.

Text Books:

1. C++ Move Semantics - The Complete Guide by Nicolai M. Josuttis, 2020.
2. C++ Concurrency in Action, 2nd Edition by Anthony Williams, 2019.
3. C++17 - The Complete Guide by Nicolai M. Josuttis, 2020.
4. C++17 In Detail: Learn the Exciting Features of The New C++ Standard! by Bartłomiej Filipek, 2019.
5. Professional C++, 4th Edition by Marc Gregoire, 2018.
6. Functional Programming in C++ by Ivan Čukić, 2018.
7. Effective Modern C++: 42 Specific Ways to Improve Your Use of C++11 and C++14 by Scott Meyers, 2015.

21OE020 Cyber Security and Privacy

Course Outcomes

3 0 0 3

At the end of the course, Student will be able to

1. Explain fundamental cyber security concepts including confidentiality, integrity, availability, and the evolution from information security to cyber security.
2. Analyze real-world cyber incidents and data breaches to identify security failures and their organizational impact
3. Apply governance, risk, compliance, security policies, and contingency planning techniques for effective cyber security management.
4. Evaluate cyber risks and security technologies such as access control, encryption, cryptography, and defense mechanisms.
5. Interpret information privacy concepts, ethical considerations, and global privacy regulations related to data protection.
6. Assess legal, economic, and strategic trade-offs between privacy, security, and safety using global and Indian regulatory frameworks.

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO6	PO12
1	3	2	-	-	1	1
2	2	3	2	3	2	1
3	2	2	3	2	2	1
4	3	3	2	2	1	1
5	2	2	-	2	3	1
6	1	2	-	-	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit-1

Introduction to Cyber Security

Introduction to cyber security, Confidentiality, integrity, and availability. From information security to cyber security. Foundations - Fundamental concepts, CIA, CIA triangle, data breach at target. Security management: Governance, risk, and compliance (GRC)- GRC framework, security standards. Contingency planning - Incidence response, Disaster Recovery, BCP.

Evolution of Cyber Security, Types of Information, Risk management, compliance.

12 hours

Unit-2

Cyber Security Policies

Information security policy, Internet insecurity. Risk Management - Cyber Risk Identification, Assessment, and Control. Case Study- Protecting the Cheddar. Cyber security technologies : Industry perspective - Defense Technologies, Attack, Exploits. Access control, Encryption, Standards.

Role of Cyber Security Policies in Cloud and Third-Party Environments, Human Factor in Cyber Security Policies: Policy Awareness, Training, and Enforcement.

12 hours

Unit-3

Foundations of privacy

Information privacy, Measurement, Theories. Privacy Regulation Anonymity, Data Breach. Data Protection and Privacy Legislation . Privacy by Design and Privacy-Enhancing Technologies (PETs).

Privacy Risks in Digital Platforms: Social Media, Mobile Apps, and Cloud Services, Emerging Privacy Challenges in Big Data, AI, and IoT Systems.

12 hours

Unit-4

Privacy regulation in Europe

Privacy: The Indian Way - Data Protection, GDPR, DPDP, Aadhar. Privacy and security of Aadhaar Information privacy: Economics and strategy, Economic value of privacy, privacy valuation, WTA and WTC, Business strategy and privacy, espionage, Privacy vs safety.

Balancing Privacy, Business Strategy, and National Security in the Digital Age, Consent Management and User Control under DPDP Framework.

12 hours

Total: 48 Hours

Text Book:

Michael E. Whitman, Herbert J. Mattord, (2018). Principles of Information Security, 6th edition, Cengage Learning, N. Delhi.

Reference(s)

1. Darktrace, "Technology" <https://www.darktrace.com/en/technology/#machine-learning>, accessed November 2018.
2. Van Kessel, P. Is cyber security about more than protection? EY Global Information Security Survey 2018-2019.
3. Johnston, A.C. and Warkentin, M. Fear appeals and information security behaviors: An empirical study. MIS Quarterly, 2010.
4. Arce I. et al. Avoiding the top 10 software security design flaws. IEEE Computer Society Center for Secure Design (CSD), 2014.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book/Assignment Exam (%)
Remember	25	35	-
Understand	45	35	-
Apply	30	30	40
Analyze	-	-	20
Evaluate	-	-	40
Create	-	-	-
Total (%)	100	100	100

Sample Questions:

Remember

1. List the elements of the CIA triad.
2. Define Privacy by Design.
3. Define GDPR.
4. What is DPDP Act?

Understand

1. Describe cyber risk identification.
2. Summarize privacy risks in digital platforms.
3. Describe India's approach to data protection.
4. Explain economic value of privacy.

Apply

1. Apply privacy principles to social media platforms.
2. Use PETs to enhance user privacy.
3. Apply DPDP rules to an Indian organization.
4. Use consent management in digital services.

Analyze

1. Compare attack techniques and defense technologies.
2. Analyze the impact of weak cyber security policies.
3. Compare traditional and modern privacy approaches.
4. Analyze regulatory responses to data breaches.

Evaluate

1. Evaluate risks of IoT data collection.
2. Evaluate effectiveness of GDPR enforcement.
3. Assess DPDP Act's role in protecting citizens.
4. Evaluate Aadhaar privacy safeguards.

Course Outcomes

At the end of the course, students will be able to

1. Apply fundamental image processing techniques to analyze digital images in both spatial and frequency domains.
2. Utilize projective geometry principles and homography matrices to solve problems related to 2D image transformations.
3. Analyze the pinhole camera model and stereo vision geometry to determine intrinsic/extrinsic parameters and estimate depth using epipolar constraints.
4. Apply feature detection algorithms and robust matching techniques to identify keypoints and estimate geometric transformations.
5. Analyze digital images to interpret surface geometry and 3D scene structure.
6. Construct supervised and unsupervised learning models to classify and cluster visual data.

CO-PO Mapping

CO's	PO1	PO2	PO3	PO12
CO1	2	2	3	2
CO2	2	2	3	2
CO3	2	3	3	2
CO4	2	2	3	2
CO5	2	3	3	2
CO6	2	3	2	2

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I

12 Hours

Image Processing Fundamentals: introduction to Computer Vision, Digital image representation, Pixel, intensity, grayscale and color images, Image sampling and quantization, Spatial domain operations, Image filtering concepts, Convolution and correlation, Image transforms- Fourier Transform, Discrete Cosine Transform (DCT), Spatial vs frequency domain processing, Projective Geometry-Homogeneous coordinates, 2D projective space, Projective transformations, Lines and points in projective space, Homography - Definition of homography, Homography matrix, Properties of homography, Point and line mapping using homography.

Applications: image alignment, planar motion

Unit II

12 Hours

Camera Geometry : Pinhole camera model, Camera coordinate systems, World, camera and image coordinates, Intrinsic parameters, Extrinsic parameters, Camera projection equations, Camera calibration basics, Stereo Geometry-Binocular vision concept, Stereo camera setup, Correspondence problem, Epipolar geometry, Epipolar lines and epipoles, Fundamental matrix, Essential matrix, Depth estimation, Disparity and triangulation

Unit III

12 Hours

Feature Detection: Edge detection-Sobel operator, Canny edge detector, Corner detection-Harris corner detector, FAST detector, Blob detection-Laplacian of Gaussian (LoG), Difference of Gaussian (DoG), Keypoint detection concepts, Feature Description & Matching-Feature descriptors (basic concepts), Distance measures for matching, Feature correspondence, Outlier detection, Model fitting, RANSAC algorithm, Estimation of geometric transformations, Color Processing-Color fundamentals, Color perception, Color models and spaces- RGB, HSV, YCbCr, Color transformations, Color image enhancement, Color segmentation basics.

Unit IV

12 Hours

Range Image Processing: Range and depth images-Depth sensing techniques, Point clouds, Surface normal, Geometry from depth images, Range image filtering, Clustering & Classification-Introduction to

learning in computer vision, Unsupervised learning-k-means clustering, Supervised classification concepts, Linear classifiers, Decision boundaries, Performance evaluation metrics, Dimensionality Reduction-Need for dimensionality reduction, Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Sparse representation basics, Deep Neural Architectures-Introduction to neural networks, Convolutional Neural Networks (CNNs), CNN layers: convolution, pooling, fully connected, CNN training concepts, Applications of deep learning in computer vision.

Total: 48 Hours

Textbook (s)

1. R. Hartley and A. Zisserman, Multiple View Geometry in Computer Vision, Cambridge University Press, 2nd Edition, 2004.
2. R. Szeliski, Computer Vision: Algorithms and Applications, Springer, 2nd Edition, 2022.
3. D. A. Forsyth and J. Ponce, Computer Vision: A Modern Approach, Pearson Education, 2nd Edition, 2011.

Reference (s)

1. R. C. Gonzalez and R. E. Woods, Digital Image Processing, Pearson, 4th Edition, 2018.
2. I. Goodfellow, Y. Bengio, and A. Courville, Deep Learning, MIT Press, 2016.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam /Assignment (%)
Remember	20	20	--
Understand	40	40	--
Apply	20	20	50
Analyze	20	20	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember:

1. Define the term Homography and state the dimensions of a Homography matrix.
2. List the intrinsic and extrinsic parameters of a pinhole camera model.
3. State the purpose of the Fundamental Matrix in stereo geometry.
4. Define sampling and quantization in the context of digital image representation.
5. What are the three components of the HSV color model?

Understand:

1. Explain the difference between spatial domain and frequency domain processing in image analysis.
2. Describe the correspondence problem in stereo vision and why it is difficult to solve.
3. Summarize the working principle of the RANSAC algorithm for outlier detection.
4. Interpret the role of pooling layers in a Convolutional Neural Network (CNN).
5. Explain why homogeneous coordinates are necessary for representing projective transformations.

Apply:

1. Given a stereo camera setup with a baseline and focal length, calculate the depth of an object.
2. Apply the Sobel operator masks (horizontal and vertical) to a 3 x 3 image patch to compute the gradient magnitude.
3. Demonstrate how histogram equalization is used to enhance the contrast of a low-light image.
4. Use the epipolar geometry to determine the search line for a matching point in the right image, given a point in the left image.
5. Illustrate the process of dimensionality reduction using Principal Component Analysis (PCA) on a dataset of images.

Analyze:

1. Compare and contrast the Harris Corner Detector and the FAST detector in terms of computational speed and accuracy.
2. Analyze the effect of increasing the Gaussian kernel size on the results of Canny edge detection.
3. Differentiate between Supervised and Unsupervised learning approaches for image segmentation tasks.
4. Examine the relationship between depth and disparity.
5. Evaluate the limitations of linear classifiers versus Deep Neural Networks for complex object recognition tasks.

210E022 Data Visualization Techniques

3 0 0 3

Course Outcomes

At the end of the course, students will be able to

1. Explain the basics of data visualization, including its importance, aesthetics, and coordinate systems.
2. Apply data mapping techniques using colors, scales, and different visualization types.
3. Create visualizations for amounts using bar plots, dot plots, and heatmaps.
4. Analyze distributions using histograms, density plots, and Q-Q plots.
5. Illustrate proportions and nested proportions using pie charts, stacked bars, and treemaps.
6. Interpret relationships among multiple variables using scatterplots, correlograms, and dimension reduction techniques.

COs-POs Mapping

COs	PO1	PO2	PO3	PO5	PO10
1	3	2	-	2	3
2	3	2	3	3	1
3	2	3	3	3	2
4	3	3	2	2	2
5	3	2	3	2	1
6	3	3	3	2	3

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I

12 hours

Introduction to Data Visualization

Introduction: Definition, Importance of Data Visualization, Ugly, Bad, and Wrong figures,

Visualizing Data: Mapping Data onto Aesthetics - Aesthetics and Types of Data, Scales Map Data Values onto Aesthetics, Coordinate Systems and Axes - Cartesian Coordinates, Nonlinear Axes, Coordinate Systems with Curved Axes.

Advantages of Data Visualization, Limitations of Data Visualization

Unit II

12 hours

From Data to Visualization

Color Scales: Color as a Tool to Distinguish, Color to Represent Data Values, Color as a Tool to Highlight

Directory of Visualizations: Amounts, Distributions, Proportions, x-y relationships, Geospatial Data, Uncertainty

Visualizing Amounts: Bar plots, Grouped and stacked bars, Dot Plots and Heatmaps

Visualizing Distributions: Histograms and Density Plots - Visualizing a Single Distribution, Visualizing Multiple Distributions at the Same Time

Geospatial Data- Projections, Layers, Choropleth, Cartograms

Unit III

12 hours

Visualizing Distributions: Empirical Cumulative Distribution Functions and Q-Q Plots - Empirical Cumulative Distribution Functions, Highly Skewed Distributions, Quantile-Quantile Plots

Visualizing Many Distributions at Once: Visualizing Distributions Along the Vertical Axis, Visualizing Distributions Along the Horizontal Axis.

Visualizing Proportions:

A Case for Pie Charts, A Case for Side-by-Side Bars, A Case for Stacked Bars and Stacked Densities, Visualizing Proportions Separately as Parts of the Total.

Individual Time Series, Multiple Time Series and Dose- Response Curves.

Unit IV

12 hours

Visualizing Nested Proportions: Nested Proportions Gone Wrong, Mosaic Plots and Tree maps, Nested Pies, Parallel Sets

Visualizing Associations Among Two or More Quantitative Variables: Scatterplots, Correlograms, Dimension Reduction, Paired Data.

Visualizing Trends- Smoothing, Showing Trends with a Defined Functional Form, Detrending and Time-Series Decomposition

Visualization Tools - Tableau, Power BI, Qlik, and Infogram.

Total: 48hours

Textbook (s)

1. Claus Wilke, "Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures", 1st edition, O'Reilly Media Inc, 2019.
2. Tony Fischetti, Brett Lantz, R: Data Analysis and Visualization, O'Reilly, 2016
3. Ossama Embarak, Data Analysis and Visualization Using Python: Analyze Data to Create Visualizations for BI Systems, Press, 2018

Reference (s)

1. "Data Visualisation: A Handbook for Data Driven Design" by Andy Kirk
2. "Fundamentals of Data Visualization" by Stephen Few
3. "The Big Book of Dashboards: Visualizing Your Data Using Real-World Business Scenarios" by Andy Kirk

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam /Assignment (%)
Remember	20	20	--
Understand	40	40	--
Apply	20	20	50
Analyze	20	20	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember:

1. Define data visualization and explain its importance.
2. List the different types of coordinate systems used in data visualization.
3. Identify the key components of mapping data onto aesthetics.
4. Name different types of plots used to visualize distributions.
5. Recall the various methods used to visualize proportions.

Understand:

1. Explain how aesthetics and data types of influence data visualization.
2. Describe the role of colour in distinguishing, representing, and highlighting data values.
3. Differentiate between Cartesian coordinates and coordinate systems with curved axes.
4. Interpret the significance of histograms and density plots in visualizing distributions.
5. Summarize the advantages and limitations of using pie charts, stacked bars, and treemaps for visualizing proportions.

Apply:

1. Apply appropriate aesthetics to visualize a dataset with categorical and numerical variables.
2. Use a color scale to highlight key trends in a heatmap representation of sales data.
3. Construct a histogram and density plot to compare the distribution of two different datasets.
4. Demonstrate the use of stacked bar charts to represent population proportions across multiple

regions.

5. Implement a scatterplot to analyze the relationship between two quantitative variables in a given dataset.

Analyze:

1. Analyze the impact of choosing nonlinear axes instead of Cartesian coordinates in data visualization.
2. Compare different visualization techniques for representing proportions, such as pie charts, stacked bars, and treemaps.
3. Examine how colour scales affect the interpretation of data in heatmaps and density plots.
4. Differentiate between empirical cumulative distribution functions and Q-Q plots for analyzing distributions.
5. Investigate how dimension reduction techniques help in visualizing high-dimensional data relationships.

Course outcomes:

1. Explain the various physiological functions of our body and the test methods for periodical monitoring of health
2. Determine the physical hazard at workplace and suggest control measures.
3. Explain the chemical and ergonomical hazards at workplace with adequate mitigating actions
4. Identify notifiable occupational diseases arising out of Occupation and suggest methods for the prevention of such diseases.
5. Explain occupational physiology and toxicology
6. Evaluate the biological and ergonomical hazards at workplace and associated risk factors

COs – POs Mapping

COs	PO ₁	PO ₃	PO ₆	PO ₇	PO ₈	PO ₁₀	PO ₁₂
1	2	2	3	1	2	2	2
2	2	2	3	1	2	2	2
3	2	2	3	1	2	2	2
4	2	2	3	-	2	2	2
5	2	2	3	-	2	2	2
6	2	2	3	-	2	2	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

UNIT I**PHYSICAL HAZARDS**

Anatomy and Physiology of human organs. Functions of organs – Effects of various hazards on organs - audiometric tests, eye tests, vital functional tests. Exposure routes of toxic materials and protective mechanisms, Methods for measuring and evaluating health hazards.

Noise, compensation aspects, noise exposure regulation, properties of sound, occupational damage, risk factors, sound measuring instruments, noise control program, industrial audiometry. Vibration, types, effects, instruments, surveying procedure, permissible exposure limit. Ionizing radiation, types, effects, monitoring instruments, control programs, OSHA standard- nonionizing radiations, effects, types, radar hazards, microwaves and radio-waves, lasers.

12 Hours**UNIT II****CHEMICAL AND ERGONOMICAL HAZARDS**

Recognition of chemical hazards-dust, fumes, mist, vapour, fog, gases, types, concentration, Exposure vs. dose, TLV - Methods of Evaluation, process or operation description, Field Survey, Sampling methodology, Industrial Hygiene calculations, Comparison with OSHAS Standard. Air Sampling instruments, Types, Measurement Procedures, Instruments Procedures, Gas and Vapour monitors, dust sample collection devices, Methods of Control - Engineering Control, Design maintenance considerations, design specifications - General Control Methods - training and education. Work Related Musculoskeletal Disorders –carpal tunnel syndrome CTS- Tendon pain-disorders of the neck- back injuries.

12 Hours**UNIT III****OCCUPATIONAL HEALTH, PHYSIOLOGY AND TOXICOLOGY**

Concept and spectrum of health - functional units and activities of occupational health services, pre-employment and post-employment medical examinations - occupational related diseases, notifiable occupational diseases such as silicosis, asbestosis, pneumoconiosis, siderosis, anthracosis, etc, gas poisoning- effects and prevention – cardio pulmonary resuscitation, audiometric tests, eye tests, vital function tests.

Occupational Physiology-Man as a system component – allocation of functions – efficiency – occupational work capacity – aerobic and anaerobic work – evaluation of physiological requirements of jobs – parameters of measurements. Industrial toxicology, local, systemic and chronic effects, temporary and cumulative effects, carcinogens entry into human systems.

12 Hours**UNIT IV****ERGONOMICS AND HUMAN FACTORS IN SAFETY**

Ergonomics and its areas of application in the work system. Human Factors and Ergonomics-Systems of the Human Body- Anatomy, Posture and Bio Mechanics: Basic bio mechanics and anatomy of the spine and pelvis, Bio Mechanical aspect of body movement.

Anthropometry- anthropometry and its uses in ergonomics, principles of applied anthropometry in ergonomics, application of anthropometry in design. An ergonomics approach to work station design, design for standing workers, design for seated workers, work surface design, visual display units, guidelines for design of static work.

12 Hours

TOTAL: 48 Hours

Textbook(s):

1. Benjamin O.Alli, Fundamental Principles of Occupational Health and Safety ILO 2008

References:

1. Danuta Koradecka, Handbook of Occupational Health and Safety, CRC, 2010.
2. E.J. McCornick, and M. S Sanders, Human Factors in Engineering and Design, Tata McGraw-Hill, 1992.
3. Encyclopedia of "Occupational Health and Safety", Vol.I, II, published by International Labour Office, Geneva, 1985
4. Hand book of "Occupational Safety and Health", National Safety Council, Chicago, 2002.
5. Lawrence Slote , Handbook of occupational safety and health, Wiley, 2001.
6. Louis J. Di Berardinis, Handbook of occupational safety and health Wiley, 1999.

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	30	30	-
Understand	40	40	30
Apply	30	30	70
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

1. List the ill effects in human due to overexposure of noise.
2. What are the types of ionizing radiation?
3. When an employer has to provide hearing protectors?
4. Discuss radiation sources in humans.
5. List out some common techniques to analyze gaseous pollutants.
6. Write commonly used sound absorption materials.
7. What are the methods for controlling bio-hazardous agents in workers?
8. When will you conduct audio metric test?
9. Does physiology affects productivity? Justify your answer.
10. Compare pre-employment and post-employment medical examination.

Understand

1. Explain in detail about the noise control strategies.
2. Discuss the monitoring instrument of ionizing radiation.
3. Explain mechanisms involved in noise control system.
4. Elaborate health concerns of people working in cold environment.
5. Discuss in detail ambient air sampling techniques.
6. Discuss causes and prevention of neck and back pain.
7. Discuss in detail classification of biohazards.

Apply

1. List some common prevention for various occupational diseases

2. What are the various eye test and vital functional test conducted in workers?
3. Identify the preventive measures to be adopted for skeletal disorders.
4. Examine the symptoms, causes and preventive measures of silicosis.
5. Analyze how shift work physiologically influence workers?

Course Outcomes:

1. Outline the safety rules, standards and codes in various mechanical engineering processes.
2. Explain various machine guarding systems for lathe, drilling, boring and milling machines.
3. Develop safe procedures for welding, cold forming and hot working of metals.
4. Explain the sources of fire, their prevention techniques and fire suppression systems
5. Explain the concepts of reliability and risk assessment
6. Predict and estimate reliability of various systems

COs – POs Mapping

COs	PO ₁	PO ₃	PO ₆	PO ₈	PO ₁₀	PO ₁₂	PSO ₂
1	2	3	2	2	2	3	2
2	2	3	2	2	2	3	2
3	2	3	2	2	2	3	2
4	2	3	2	2	2	3	2
5	2	3	2	2	2	3	2
6	2	3	2	2	2	3	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

SAFETY IN METAL WORKING MACHINERY AND PRINCIPLES OF MACHINE GUARDING

General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines, CNC machines, Wood working machinery, safety principles, electrical guards, work area, material handling, inspection.

Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS – guarding of hazards - point of operation protective devices, machine guarding, types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing- guard construction- guard opening.

12 Hours

Unit II

SAFETY IN WELDING, COLD FORMING AND HOT WORKING OF METALS

Gas welding and oxygen cutting, resistance welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in brazing and soldering– explosive welding, selection, care and maintenance of the associated equipment and instruments.

Cold working, power presses, point of operation safe guarding, power press electric controls, inspection and maintenance-metal sheers-press brakes.

Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills – hazards and control measures. Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes. Personal protective equipment (PPE).

12 Hours

Unit III

FIRE PREVENTION AND PROTECTION SYSTEMS

Sources of ignition – fire triangle – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – A, B, C, D, E-Fire extinguishing agents- Water, Foam, Dry chemical powder, Carbon-dioxide, Halon alternatives, Halocarbon compounds-Inert gases , dry powders – types of fire extinguishers.

Sprinkler-hydrants-stand pipes – special fire suppression systems-Other suppression systems – CO₂ system, foam system, dry chemical powder (DCP) system, halon system.

12 Hours

Unit IV

RELIABILITY CONCEPT

Reliability function – failure rate – mean time between failures (MTBF) – mean time to failure (MTTF) –mortality curve – useful life – availability – maintainability – system effectiveness. Reliability Prediction Models- Series and parallel systems, Markov analysis – Fault Tree Analysis

RISK ASSESSMENT

Definition and measurement of risk – risk analysis techniques – risk reduction resources – industrial safety and risk assessment.

12 Hours

TOTAL: 48 Hours

Textbook(s):

1. Philip Hagan “Accident Prevention Manual for Business and Industry”, N.S.C. Chicago, 13th edition, 2009.
2. John V. Grimaldi and Rollin H.Simonds, “Safety Management”, Richard D Irwin, 1994.

References:

1. “Occupational safety Manual” BHEL, Trichy, 1988.
2. Krishnan N.V. “Safety Management in Industry” Jaico Publishing House, Bombay, 1997.
3. “The Indian boilers act 1923 with amendments”, Law Publishers (India) Pvt. Ltd., Allahabad.
4. “Health and Safety in Welding and Allied processes”, Welding Institute, UK, High Tech. Publishing Ltd., London, 1989.
5. “Safe use of wood working machinery”, HSE, UK, 2005. “ISO 14020:2000 Environmental Labels and Declarations-General Principles”, ISO, 2000.

Sample Question(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	30	30	-
Understand	35	35	30
Apply	35	35	70
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

1. Define Zero Mechanical State.
2. What are the safety measures to be followed in CNC machines?
3. List the safety prevention to be taken care in Wood working machinery
4. Identify the elements that are required to start and sustain fire.
5. Outline the various classification of Fire.
6. What is fire triangle?
7. List the factors to be considered for safety in forging, hot rolling mill operation.
8. Summarize how hazard rate is estimated.
9. Define bath tub curve.

Understand

1. Summarize the mechanical hazards and the basic requirements of mechanical guards
2. List down the steps of organizing for fire protection.
3. Explain the safety precautions in brazing and soldering.
4. Describe the types of fire extinguishers.
5. Explain the following fire suppression systems:

CO₂ system, foam system, dry chemical powder system, halon system.

6. Explain the terms failure rate, MTBF, and MTTF
7. Explain the characteristics and functions of a bath tub curve.

Apply

1. Summarize OSHA fire standards for fire prevention and suppression.
2. Evaluate the procedure to be followed when an emergency fire has started.
3. Explain the Personal protective equipment (PPE).

210E025 RELIABILITY ENGINEERING AND INTEGRATED MANAGEMENT SYSTEMS

3 0 0 3

Course Outcomes

1. Explain the significance of reliability metrics and apply failure data analysis using exponential, normal, gamma and Weibull distribution
2. Solve problems and work on m/n configuration systems, series parallel systems.
3. Conduct risk assessment to identify the industrial problem and provide suitable solution
4. Explain the basic concepts and knowledge about occupational health and safety management systems
5. Explain the structure and features of OHSAS 18001.
6. Explain the significance of ISO 45001 OSHMS.

COs - POs Mapping

COs	PO ₁	PO ₃	PO ₆	PO ₈	PO ₁₀	PO ₁₂	PSO ₂
1	2	3	2	2	2	2	2
2	2	3	2	2	2	2	2
3	2	3	2	2	2	2	2
4	2	3	2	2	2	2	2
5	2	3	2	2	2	2	2
6	2	3	2	2	2	2	2

3 - Strongly linked | 2 - Moderately linked | 1 - Weakly linked

Unit I

RELIABILITY and FAILURE DATA ANALYSIS

Reliability function - failure rate - mean time between failures (MTBF) - mean time to failure (MTTF) -- mortality curve - useful life - availability - maintainability - system effectiveness.

Time to failure distributions - Exponential, normal, Gamma, Weibull - ranking of data - probability plotting techniques - Hazard plotting.

12 Hours

Unit II

RELIABILITY PREDICTION MODELS and RISK ASSESSMENT

Series and parallel systems - RBD approach - Standby systems - m/n configuration - Application of Bayes' theorem - cut and tie set method - Markov analysis - Fault Tree Analysis - limitations.

Risk Assessment-Definition and measurement of risk - risk analysis techniques - risk reduction resources - industrial safety and risk assessment.

12 Hours

Unit III

OHSAS Standard

OHSAS Standard Introduction - Development of OHSAS standard - Structure and features of OSHAS 18001 -FOHSR -Planning - Guidelines, methodology steps developing action plan-OHSAP -OH&S policy- certification procedure - OH & S management system element, specification and scope- Benefits of certification of OHSAS 18001- correspondence between OHSAS 18001, ISO22000, ISO18001, ISO 15001, ISO 14001:1996 and ISO 9001:1994 - Guidelines (18002:2000) for implementing OHSAS 18001.

12 Hours

UNIT IV

ISO 45001 Standard

ISO 45001 ISO 45001- need for ISO 45001 - Terms and definitions -structure and features of ISO 45001- contents of ISO 45001- developing OH&S Policy -guidelines- Benefits -Certification Procedure-correspondence between OHSAS 18001 and ISO 45001. Gap Analysis -migration from OHSAS 18001 to ISO 45001. ISO 45001 Implementation and Operation, OHSMS audit -Continual improvement - Beyond ISO 45001.

12 Hours

TOTAL: 48 Hours

Textbook(s):

1. Charles E Ebeling, "An Introduction to Reliability and Maintainability Engineering", McGraw Hill Education, 12th edition 2017.
2. Arora K C Dr, "ISO 9000 to OHSAS 18001", S.K. Kataria & Sons, Delhi, 2010.
3. ISO 45001:2018 – Occupational Health and Safety Management System

References:

1. Srinath L.S, "Reliability Engineering", East West Press, 2005.
2. Modarres, "Reliability Engineering and Risk analysis", CRC Press, 2009.
3. John Davidson, "The Reliability of Mechanical Systems" Mechanical Engineering Publications Limited, 1994.
4. Wayne Parady, Terri Andrews, "Integrated Management System", Bernan Press, 2nd Edition, 2019.
5. Ramesh C Grover, Sachin Grover, "Providing Safe & Health workplace with ISO 45001:2018", Notion Press,

Sample Question(s)**Internal Assessment Pattern**

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	30	30	-
Understand	35	35	30
Apply	35	35	70
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

1. Define Reliability.
2. Define- Mean Time Between Failures (MTBF).
3. Define- Mean Time To Failure (MTTF).
4. What is mortality curve?
5. State Bayes' theorem.
6. What is Markov analysis?
7. List the features of ISO 45001.
8. Define-Fault Tree Analysis.

Understand

1. Explain Bayes' theorem in detail.
2. Describe density functions for different types of discrete and continuous variables.
3. Differentiate between Weibull distribution, normal distribution and the lognormal distribution.
4. Define Maintainability and availability and compare it with reliability.
5. Explain Monte Carlo Simulation.
6. How will you find out reliability of systems connected in series and parallel combined? Explain with help of neat sketches.
7. Elaborate the following terms with suitable sketch. (i) Mean time to failure. (ii) Hazard rate.
8. (iii) Failure data analysis
9. What are the reliability improvement techniques? Explain any two in a detailed manner.
10. Explain the guidelines (18002:2000) for implementing OHSAS 18001.
11. Explain the objectives and need for ISO 45001.
12. Explain the structure and features of ISO 45001.

Apply

1. A complex electronic system has four vacuum tubes for operation whose MTBF is 10,000 hours. (a) if the system is changed by replacing vacuum tubes with 16 transistors the MTBF increases to 80,000 hours. find the usefulness of the transistors for reliability, (b) If the number of transistors provided are 32. Determine its effect on overall reliability of the system.
2. Determine the upper bound for each of the following aircraft subsystems MTTRs if a system availability goal of 0.95 is desired. Assume the repair restores the subsystem to as good as new and each system has the same availability.

Subsystem	Time Between failures	Parameters
Propulsion	Weibull	$\theta = 1000, \beta = 1.7$
Avionics	Exponential	$\lambda = 0.003$
Structures	Weibull	$\theta = 2000, \beta = 2.1$
Electrical	Weibull	$\theta = 870, \beta = 1.8$
Environmental	Exponential	$\lambda = 0.001$

Course Outcomes

At the end of the course, students will be able to

1. Explain the fundamentals of time series data analysis.
2. Apply various statistical and machine learning techniques to model time series data.
3. Implement time series models using Python libraries.
4. Visualize time series data and interpret key patterns and trends.
5. Analyse and forecast time series data using advanced techniques.
6. Solve real-world time series problems through case studies.

COs-POs Mapping

COs	PO1	PO2	PO3	PO10	PO12
1	3	3	-	1	2
2	2	2	2	2	2
3	3	3	3	2	2
4	3	2	3	3	2
5	3	2	2	2	2
6	3	3	2	1	2

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

UNIT-I Fundamentals of Time Series Data

12 hours

Introduction to Time Series - Trend, seasonality, cyclicity, and irregularity. **Different types of time series data** - Univariate vs Multivariate, Cross-sectional, Time Series Data, panel data. **Models for time series analysis** - Zero mean models, Random Walk, Trend models, and Seasonality models. **Exploratory Data Analysis (EDA)**-Data Cleaning and Handling Missing Data, Basic Time Series Visualizations (Line plots, ACF, PACF), Autocorrelation and Partial Autocorrelation Functions, Time Series Decomposition.

Fourier Analysis in Time Series, Wavelet Transform for Time Series Analysis

UNIT-II Time Series Modelling with Machine Learning

12 Hours

Introduction to Machine Learning for Time Series: Supervised vs Unsupervised Learning, Feature Engineering for Time Series, and Time Series Forecasting vs Classification. **Autoregressive Integrated Moving Average (ARIMA)**- Overview of AR, MA, and ARIMA Models, Hyperparameter Tuning using ACF and PACF, and Forecasting with ARIMA. **Machine Learning Algorithms for Time Series** -Random Forests for Time Series Forecasting, XGBoost and Gradient Boosting for Time Series Data. **Handling Non-Stationary Data**- Differencing and Transformation Techniques.

Anomaly Detection in Time Series using Isolation Forests, Transfer Learning for Time Series Forecasting

Unit-III Advanced Time Series Modelling

12 hours

Seasonal Decomposition of Time Series (STL)- Decomposition using Seasonal-Trend decomposition using LOESS, Modelling and Forecasting with Seasonal Decomposition. **Long Short-Term Memory (LSTM) Networks** -Introduction to Recurrent Neural Networks (RNNs), Building LSTM Models for Time Series Forecasting, Hyperparameter Tuning, **Model Evaluation and Selection**- Cross-validation for Time Series Data and Metrics: RMSE, MAE, MAPE, AIC, BIC.

Bayesian Methods for Time Series Forecasting, Hybrid Models (Combining ARIMA with Machine Learning)

Unit-IV: Time Series Data Visualization and Case Studies

12 hours

Time Series Visualization Techniques: Visualizing Trends, Seasonality, and Anomalies, Advanced Visualization: Heatmaps, Boxplots, Violin Plots, Dynamic Plots using Plotly and Matplotlib, **Case Studies and Applications:** Case Study 1: Forecasting Stock Prices, Case Study 2: Predicting Electricity Consumption, Case Study 3: Sales Forecasting using Machine Learning.

Geospatial Time Series Analysis, Real-Time Time Series Forecasting Systems

Total: 48hours

Textbooks

1. Practical time series analysis: master time series data processing, visualization, and modelling using Python, 1st edition, Avishek Pal and PKS Prakash, Packt Publishing, 2017.
2. Machine Learning for Time-Series with Python: Forecast, predict, and detect anomalies with state-of-the-art machine learning methods, 1st edition, Ben Auffarth, Packt Publishing, 2021.
3. Time Series Analysis with Python Cookbook: Practical recipes for exploratory data analysis, data preparation, forecasting, and model evaluation, 1st edition, Tarek A. Atwan, Packt Publishing, 2022

References:

1. Introduction to Time Series Forecasting with Python - How to Prepare Data and Develop Models to Predict the Future, 1st edition, Jason Brownlee, v1.9, 2020.
2. Pandas Cookbook: Recipes for Scientific Computing, Time Series Analysis and Data Visualization using Python, 1st edition, Theodore Petrou, Packt Publishing, 2017.
3. Online Resources:
 - o www.machinelearningmastery.com
 - o www.kaggle.com

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	20	20	--
Understand	40	40	--
Apply	20	20	50
Analyze	20	20	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Sample Questions

Remember:

1. Define time series data and explain its key characteristics.
2. What are the components of a time series? Provide examples.
3. Define stationarity in time series and explain its importance in modelling.
4. What is the purpose of ACF (Autocorrelation Function) and PACF (Partial Autocorrelation Function)?
5. List the different methods used for time series decomposition.

Understand:

1. Explain the difference between univariate and multivariate time series data.
2. Describe the concept of seasonality in time series and how it can be detected.
3. How does the Augmented Dickey-Fuller (ADF) test work, and what does it indicate?
4. Explain how moving averages can be used for trend estimation.
5. What is the significance of using train-test splits in time series modelling?

Apply:

1. Given the time series data: **[120, 135, 150, 165, 180, 195, 210]**, apply a 3-point moving average to smooth the series.
2. Perform first-order differencing on the following time series: **[10, 20, 30, 40, 50]**.

3. Given an AR(1) model $Y(t) = 0.7Y(t-1) + \epsilon(t)$, forecast the next value when $Y(5) = 100$ and $\epsilon(5) = 2$.
4. Using Python, apply the **Augmented Dickey-Fuller test** on a given dataset and interpret the result.
5. Given a dataset of monthly sales, build an ARIMA model and forecast the next 6 months.

Analyse:

1. Compare and contrast ARIMA and LSTM models for time series forecasting.
2. Analyse the impact of differencing on stationarity and model performance.
3. Compare the computational efficiency of Random Forest, XGBoost, and Neural Networks in time series forecasting.
4. Discuss the advantages and limitations of using Facebook Prophet for time series prediction.
5. Analyse the importance of cross-validation in time series forecasting and compare different techniques.

Course Outcomes

At the end of the course, students will be able to

1. Explain AI and Business Intelligence concepts and their role in improving business processes.
2. Demonstrate an understanding of Business Analytics, data-driven decision-making techniques.
3. Apply machine learning techniques to solve business problems like customer segmentation and sales forecasting.
4. Apply forecasting techniques such as time-series analysis, ARIMA, and regression models to support business decision-making and optimize performance.
5. Demonstrate understanding about AI-driven decision support systems for business strategies.
6. Analyze real-world business cases and identify AI-powered BI tools for innovation.

COs-POs Mapping

COs	PO1	PO2	PO3	PO5	PO12
1	3	2	2	2	2
2	3	3	2	3	3
3	3	3	3	3	2
4	3	3	3	3	2
5	3	3	3	3	2
6	3	3	3	3	1

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I

12 hours

Introduction to Artificial Intelligence and Business Intelligence

Artificial Intelligence: Definition and scope of AI, Types of AI: Narrow AI, General AI, and Super intelligence, Applications of AI in business

Fundamentals of Business Intelligence: Definition and components of Business Intelligence (BI), Data Collection and Data Sources, Relationship between AI and BI

AI and BI Integration: Role of AI in enhancing BI capabilities, Data-driven business strategies.

BI tools and technologies

Unit II

12 hours

Introduction to Business Analytics

Introduction to Business Analytics, need and science of data driven (DD) decision making, Descriptive, predictive, prescriptive analytics and techniques, big data analytics, Web and Social media analytics, Machine Learning algorithms, framework for decision making, challenges in DD decision making and future. Recommender Systems, Automated Decision-Making, Reinforcement Learning for Decision-Making.

Business Analytics tools, Social Media KPIs

Unit III

12 hours

Machine Learning Models for Business Intelligence

Data mining, Text mining, Web mining, Spatial mining, Process mining, Data warehouse and datamarts.

Data mining process KDD, CRISP-DM, SEMMA and Domain-Specific, Classification and Prediction performance measures -RSME, MAD, MAP, MAPE, Confusion matrix.

Application of ML models in sales forecasting, customer segmentation, Applications in market basket analysis.

SVM, Ensemble Models

Unit IV

12hours

AI for Predictive and Prescriptive Analytics in Business

Forecasting Techniques: Introduction, time-series data and components, forecasting accuracy, moving average method, single exponential smoothing, Holt's method, Holt-Winter model, Croston's forecasting method, regression model for forecasting, ARIMA, Theil's coefficient.

Coefficient of Variation, Shannon Diversity Index, Simpson's Diversity Index.

AI for decision support systems (DSS), Prescriptive models in supply chain management, inventory control

Real-world applications of AI and BI: Healthcare, Finance, Marketing, E-commerce

Total: 48 hours

Textbooks:

1. Artificial Intelligence for Business" – John Paul Mueller & Luca Massaron
2. Business Intelligence: A Managerial Perspective on Analytics" – Ramesh Sharda, Dursun Delen, and Efraim Turban
3. Artificial Intelligence for Business: A Roadmap for Getting Started with AI" – Doug Rose
4. Data Science for Business: What You Need to Know About Data Mining and Data-Analytic Thinking" – Foster Provost & Tom Fawcett
5. Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die – Eric Siegel.

Reference Books:

1. "Artificial Intelligence: A Guide for Thinking Humans" – Melanie Mitchell
2. Business Intelligence Guidebook: From Data Integration to Analytics" – Rick Sherman
3. The AI Advantage: How to Put the Artificial Intelligence Revolution to Work" – Thomas H. Davenport
4. Deep Learning for Business with Python" – Nikhil Ketkar & Jojo Moolayil

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	20	20	--
Understand	40	40	--
Apply	20	20	50
Analyze	20	20	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. Define Artificial Intelligence and Business Intelligence.
2. List five AI-powered BI tools commonly used in industries.
3. What are the key components of a Business Intelligence System?
4. Identify different types of Machine Learning algorithms used in AI for BI.
5. Describe the role of data preprocessing in Business Intelligence.

Understand

1. Explain how AI enhances Business Intelligence in decision-making.
2. Differentiate between Descriptive, Predictive, and Prescriptive Analytics in BI.
3. Describe how data visualization improves BI reporting.
4. Interpret the impact of AI-driven automation on business processes.
5. Explain the importance of data quality in AI-based BI models.

Apply:

1. Apply machine learning techniques to identify customer segments in an e-commerce business.
2. Demonstrate how to use data preprocessing techniques to clean a business dataset.

3. Given a dataset, implement a predictive analytics model to forecast sales.
4. Use AI tools to analyze customer sentiment from online reviews.
5. Design a BI dashboard using a real-world dataset to visualize business insights.

Analyze:

1. Analyze the differences between traditional BI and AI-powered BI.
2. Examine how AI-based chatbots improve customer engagement and business intelligence.
3. Compare supervised and unsupervised learning in BI applications.
4. Investigate the ethical challenges of AI in business decision-making.
5. Analyze the impact of real-time AI analytics on supply chain management.