UNITED INSTITUTE OF TECHNOLOGY

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Periyanaickenpalayam, Coimbatore – 641020

DEPARTMENT OF ROBOTICS AND AUTOMATION

QUESTION BANK

III YEAR

EVEN SEMESTER

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HEAD OF THE DEPARTMENT

ACOE **PRINCIPAL** **CHAIRMAN**

CRA 331 ROBOTS AND SYSTEMS IN SMART MANUFACTURING

UNIT I

INTRODUCTION

Types of industrial robots – Load handling capacity – general considerations in Robotic material handling-material transfer – machine loading and unloading – CNC machine tool loading – Robot centered cell

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is Robotics?	1	1	2
2.	What is material handling in robotics?	1	1	2
3.	What is meant by load carrying capacity in robotics?	1	1	2
4.	List the typical applications of robot in an industry.	1	1	2
5.	What is a Multiple-robot control?	1	1	2
6.	How can a robot be used in a work cell?	1	1	2
7.	What are the common types of robots used?	1	1	2
8.	What are the parts of a robotic cell?	1	1	2
	PART B			
1.	Explain about the types of industrial robots with neat sketches	1	2	16
2.	Briefly discuss on the load carrying capacity of a robot.	1	2	16
3.	Write about the CNC machine tool loading in detail.	1	2	16
4.	With a neat sketch explain the Robot Centred Cell.	1	2	16

UNIT II

INTRODUCTION

Factors influencing the choice of a robot – robot performance testing – economics of robotisation – Impact of robot on industry and society. Application of Robots in continuous arc welding – Spot welding – Spray painting -assembly operation – cleaning – robot for underwater applications

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What are the selection criteria of a robot?	2	1	2
2.	What are the applications of robots in underwater?	2	1	2
3.	Where is robot welding used?	2	1	2
4.	What are the components of the underwater robot?	2	1	2
5.	List any four factors influencing the choice of robot.	2	1	2
6.	What is the purpose of robotization?	2	1	2
7.	How robots are used in Automated Inspection and Quality Control?	2	1	2
8.	How can robots be used underwater?	2	1	2
	PART B			
1.	How does a robot employed in continuous arc welding? Explain in detail.	2	2	16
2.	Explain the factors influencing the choice of robot in detail.	2	2	16
3.	Briefly explain the underwater applications of robot.	2	2	16
4.	Discuss on the impact of robot in industry and society.	2	2	16

UNIT III

MATERIAL HANDLING

Concepts of material handling - principles and considerations in material handling systems design - conventional material handling systems - industrial trucks - monorails - rail guided vehicles - conveyor systems -cranes and hoists - advanced material handling systems - automated guided vehicle systems - automated storage and retrieval systems(ASRS) - bar code technology - radio frequency identification technology -Introduction to Automation Plant design software.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is the importance of material handling?	3	1	2
2.	What are the considerations in material handling system design?	3	1	2
3.	How are industrial trucks classified?	3	1	2
4.	What is the basis for the classification of commercial vehicles?	3	1	2
5.	How a rail does guided vehicle work?	3	1	2
6.	How does an electric train rail work?	3	1	2
7.	Give an example of a hoist.	3	1	2
8.	What is the ASRS used for?	3	1	2
	PART B			
1.	Explain briefly on traditional method of material handling equipment .	3	2	16
2.	Explain about the conveyer system with its types.	3	2	16
3.	Explain the automated storage and retrieval systems (ASRS) in detail.	3	2	16
4.	Explain about the bar coding technique in detail.	3	2	16

UNIT IV

ROBOTIC WELDING

Robotic welding system, Programmable and flexible control facility -Introduction-Types-Flex Pendant-Lead through programming, Operating mode of robot, Jogging-Types, programming for robotic welding, Welding simulation, Welding sequences, Profile welding

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Why is robotic welding good?	4	1	2
2.	What is the difference between programmable and flexible automation?	4	1	2
3.	What is a programmable automation?	4	1	2
4.	What is Flex Pendant?	4	1	2
5.	Distinguish lead through and offline programming.	4	2	2
6.	What are the advantages of lead through programming?	4	1	2
7.	What is the purpose of welding simulator?	4	1	2
8.	What are the operating modes of robots?	4	1	2
	PART B			
1.	Explain the Robotic welding system in brief.	4	2	16
2.	Explain lead through programming with its advantages, disadvantages and applications.	4	2	16
3.	Elaborate the Welding simulation software in brief.	4	2	16
4.	Discuss briefly on industrial automation systems.	4	2	16

UNIT V

APPLICATION OF ROBOT IN WELDING AND ALLIED PROCESSES

Application of robot in manufacturing: Exploration of practical application of robots in welding: Robots for car body's welding, robots for box fabrication, robots for microelectronic welding and soldering – Applications in nuclear, aerospace and ship building, case studies for simple and complex applications

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What are the applications of robots in welding?	5	1	2
2.	What are the benefits of welding robots?	5	1	2
3.	What type of robot is used in spot welding applications?	5	1	2
4.	Do welding robots have sensors?	5	1	2
5.	What are the two most used welding applications for robotics?	5	2	2
6.	Which robots are very useful in packaging industry?	5	1	2
7.	Which type of robots is good for pick and place or welding operations?	5	1	2
8.	How are robots used in aerospace?	5	1	2
	PART B			
1.	Discuss briefly about the practical application of robots in welding.	5	2	16
2.	Explain the applications of robot in nuclear industry.	5	2	16
3.	Explain the applications of robot in aerospace and ship building	5	2	16
4.	Elaborate the usage of robots in packing industry	5	2	16

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RA3601
ROBOT DYNAMICS AND CONTROL

UNIT I

ROBOT FORCE MODELS

Generalized co-ordinates – Generalized Forces – Equation of Motions – Static Forces in Manipulators - Jacobian matrix - Jacobians in The Force Domain - Cartesian Transformation of Velocities and Static Forces - Acceleration of A Rigid Body - Mass Distribution – Nonrigid Body Effects - Newton's Equation - Euler's Equation – Langrage Equation

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define generalized co-ordinates.	1	1	2
2.	Define generalized forces.	1	1	2
3.	What do you understand from equations of motions?	1	1	2
4.	Define Jacobian matrix.	1	1	2
5.	Define Newton’s equation.	1	1	2
6.	Explain the importance of Euler’s equation.	1	2	2
7.	Define Langrage equation.	1	1	2
8.	Explain the concept of static forces.	1	2	2
	PART B			
1.	Enumerate about the static forces in manipulators.	1	4	16
2.	Explain about the Jacobians in the force domain.	1	4	16
3.	Derive and explain about the acceleration of a rigid body.	1	4	16
4.	Explain about the mass distribution with neat sketch.	1	4	16

UNIT II

ROBOT DYNAMICS

General Expressions for Kinetic and Potential Energy - Kinetic Energy for an n-Link Robot – Potential Energy for an n-Link Robot - Equations of Motion - Lagrangian Multiplier - Langrage's Equation - Hamilton Equation - Hamilton vector Field- Euler - Langrage Equation – State Vector and Equation Formulation

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is kinetic energy?	2	1	2
2.	What is potential energy?	2	1	2
3.	Explain about the equations of motion.	2	2	2
4.	Define Langragian multiplier.	2	1	2
5.	What is Langrage equation?	2	1	2
6.	What is Hamilton equation?	2	1	2
7.	Define Euler-Langrage equation.	2	1	2
8.	What is meant by Hamilton vector field?	2	1	2
	PART B			
1.	Derive the general expressions for kinetic and potential energy.	2	4	16
2.	Explain about the kinetic energy for an n-link robot and potential energy for an n-link robot.	2	4	16
3.	Enumerate about the various equations of motion.	2	4	16
4.	Derive the expression for Euler-Langrage equation.	2	4	16

UNIT III

ROBOT CONTROL SYSTEM

The manipulator control problem, Linear second-order model of manipulator. Functions of controller and power amplifier. Joint actuators- stepper motor, servo motor. Control Schemes: PID control scheme – Position and force control schemes. Robotic sensors and its classification, Internal sensors – Position, velocity, acceleration and force information, External Sensors – Contact sensors-Limit switches, piezoelectric, pressure pads, Non-contact sensors – Range sensors, Vision sensor- robotic vision system, Description of components of vision system.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	List the functions of controller.	3	1	2
2.	List the functions of power amplifier.	3	1	2
3.	Compare stepper motor and servo motor.	3	2	2
4.	Define internal sensors and its types.	3	1	2
5.	Define external sensors and its types.	3	1	2
6.	Explain about the robotic vision system.	3	2	2
7.	Explain about the contact sensor and its types.	3	2	2
8.	Explain about the non-contact sensors and its types.	3	2	2
	PART B			
1.	Enumerate about the internal sensor types with neat sketch.	3	4	16
2.	Discuss about the contact sensor and explain any one type with neat sketch.	3	4	16
3.	Discuss about the non-contact sensor and explain any one type with neat sketch.	3	4	16
4.	Explain the working principle, construction, advantages and disadvantages of stepper motor and servo motor with neat sketch.	3	4	16

UNIT IV

CONTROL OF MANIPULATORS

Linear Time Varying and Linearization – Input and Output Stability - Background: The Frobenius Theorem - Single-Input Systems. Introduction to nonlinear system – time varying systems – multi-input, multi-output control systems - the control problem for manipulators – practical considerations - current industrial-robot control systems - Lyapunov stability analysis – Cartesian – based control systems - adaptive control - Limit Cycle - Describing Function

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is multi-input control system?	4	1	2
2.	What is multi-output control system?	4	1	2
3.	Define Frobenius theorem.	4	1	2
4.	Define limit cycle.	4	1	2
5.	What is meant by adaptive control?	4	1	2
6.	Define Lyapunov stability analysis.	4	1	2
7.	Define Single-Input Systems.	4	1	2
8.	What is robot control systems?	4	1	2
	PART B			
1.	Explain about the background Frobenius theorem.	4	4	16
2.	With a neat sketch explain about the Lyapunov stability analysis and adaptive control.	4	4	16
3.	Enumerate about the multi-input and multi-output control system.	4	4	16
4.	Explain about the Linear Time Varying and Linearization.	4	4	16

UNIT V

FORCE CONTROL

Constrained Dynamics - Static Force/Torque Relationships - Constraint Surfaces - Natural and Artificial Constraints - Network Models and Impedance - Impedance Operators - Classification of Impedance Operators - Force Control Strategies - Impedance Control - Hybrid Impedance Control.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is meant by constrained dynamics?	5	1	2
2.	Compare natural and artificial constraints.	5	2	2
3.	Define constraint surface.	5	1	2
4.	What is hybrid impedance control?	5	1	2
5.	Define Impedence.	5	1	2
6.	Define Network models.	5	1	2
7.	Explain about the force control strategies.	5	2	2
8.	What is Impedance Operators?	5	1	2
	PART B			
1.	Explain about the network models and impedance.	5	4	16
2.	Enumerate about the hybrid impedance control.	5	4	16
3.	What is constrained dynamics? Explain about the static force/torque relationship.	5	4	16
4.	Discuss about the force control strategies and impedance control.	5	4	16

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ME3792

COMPUTER INTEGRATED MANUFACTURING

Unit 1

INTRODUCTION

Introduction to CAD, CAM, CAD/CAM and CIM - Evolution of CIM - CIM wheel and cycle - Production concepts and mathematical models - Simple problems in production models - CIM hardware and software - Major elements of CIM system - Three step process for implementation of CIM - Computers in CIM - Computer networks for manufacturing - The future automated factory - Management of CIM - safety aspects of CIM- advances in CIM

Q.No	Question	CO	BTL	Marks
	Part A			
1.	Define CAD and CAM.	1	1	2
2.	Explain the concept of the CIM wheel.	1	2	2
3.	Differentiate between CAD, CAM, and CAD/CAM.	1	2	2
4.	List any four major elements of a CIM system	1	1	2
5.	What are the three steps in CIM implementation?	1	1	2
6.	Give two examples of production mathematical models.	1	2	2
7.	Why is computer networking important in CIM?	1	1	2
8.	What are the safety aspects of CIM?	1	1	2
	Part B			
1.	Explain the different components of the CIM cycle with a neat sketch.	1	2	16
2.	How do hardware and software components integrate in CIM?	1	1	16
3.	Describe the role of computer networks in manufacturing.	1	2	16
4.	Discuss the concept of an automated factory and its future trends.	1	6	16

Unit 2

AUTOMATED MANUFACTURING SYSTEMS

Automated production line - system configurations, work part transfer mechanisms - Fundamentals of Automated assembly system - System configuration, Part delivery at workstations - Design for automated assembly - Overview of material handling equipments - Consideration in material handling system design - The 10 principles of Material handling.

Conveyor systems - Types of conveyors - Operations and features. Automated Guided Vehicle system - Types &applications - Vehicle guidance technology - Vehicle management and safety.

Storage system performance - storage location strategies - Conventional storage methods and equipments - Automated storage/Retrieval system and Carousel storage system Deadlocks in Automated manufacturing systems - Petrinet models - Applications in Dead lock avoidance - smart manufacturing - Industry 4.0 - Digital manufacturing - Virtual manufacturing

Q.No	Question	CO	BTL	Marks
	Part A			
1.	Define an automated production line.	2	1	2
2.	List the different system configurations in an automated production line.	2	1	2
3.	What are work part transfer mechanisms?	2	1	2
4.	Mention any two fundamentals of an automated assembly system.	2	1	2
5.	What is Design for Automated Assembly (DFA)?	2	1	2
6.	List four types of material handling equipment used in manufacturing.	2	1	2
7.	What are the 10 principles of material handling?	2	1	2
8.	Define Automated Guided Vehicle (AGV) and its purpose.	2	1	2

Part B

1.	Discuss the various types of Automated Guided Vehicles (AGVs) and their applications.	2	6	16
2.	Explain an Automated Storage and Retrieval System (AS/RS)? Explain different types.	2	5	16
3.	Explain the fundamentals of the automated assembly system, including system configuration and part delivery mechanisms.	2	5	16
4.	Explain different types of conveyor systems and their applications in manufacturing.	2	5	16

Unit 3
GROUP TECHNOLOGY AND FMS

Part families - Visual - Parts classification and coding - Production flow analysis - Grouping of parts and Machines by rank order clustering method - Benefits of GT - Case studies. FMS - Components - workstations - FMS layout configurations - Computer control systems - FMS planning and implementation issues - Architecture of FMS - flow chart showing various operations in FMS - Machine cell design - Composite part concept, Holier method, Key machine concept - Quantitative analysis of FMS - Bottleneck model - Simple and complicated problems - Extended Bottleneck model - sizing the FMS - FMS applications, Benefits.

Q.No	Question	CO	BTL	Marks
	Part A			
1.	Define Group Technology (GT).	3	1	2
2.	What are part families in GT?	3	1	2
3.	List different methods of parts classification and coding.	3	1	2
4.	What is production flow analysis in GT?	3	1	2
5.	Define rank order clustering and its role in machine grouping.	3	1	2
6.	List any four benefits of Group Technology (GT).	3	1	2
7.	List the major components of an FMS.	3	1	2
8.	Explain the concept of the bottleneck model in FMS.	3	2	2
	Part B			
Q.No	Question	CO	BTL	Marks
1.	Explain the different methods used to classify and code parts in Group Technology.	3	5	16
2.	Explain the extended bottleneck model in FMS and its importance.	3	5	16
3.	Explain the Rank Order Clustering Method for grouping parts and machines.	3	5	16
4.	Discuss the different FMS layout configurations with neat diagrams.	3	6	16

Unit 4

PROCESS PLANNING

Process planning - Activities in process planning, Informations required. From design to process planning - classification of manufacturing processes - Selection of primary manufacturing processes - Sequencing of operations according to Anteriorities - various examples - forming of Matrix of Anteriorities - case study. Typical process sheet - case studies in Manual process planning. Computer Aided Process Planning - Process planning module and data base - Variant process planning - Two stages in VPP - Generative process planning - Flow chart showing various activities in generative PP - Semi generative process planning- Comparison of CAPP and Manual PP.

Q.No	Question	CO	BTL	Marks
	Part A			
1.	Define process planning.	4	1	2
2.	List the key activities involved in process planning.	4	1	2
3.	Differentiate between design and process planning.	4	2	2
4.	What are the primary manufacturing processes? Give two examples.	4	1	2
5.	What is the significance of forming a matrix of anteriorities?	4	1	2
6.	What is a typical process sheet?	4	1	2
7.	Define Computer-Aided Process Planning (CAPP).	4	1	2
8.	Compare Variant Process Planning (VPP) and Generative Process Planning (GPP).	4	2	2
	Part B			
1.	(a) Explain the working of the generative process planning approach with a flowchart.	4	5	16
	(b) Compare Generative Process Planning (GPP) and Semi-Generative Process Planning.	4	5	16
2.	Explain the two stages of Variant Process Planning (VPP).	4	5	16
3.	Explain the importance of process sheets and provide an example.	4	5	16
4.	Discuss the role of databases in Computer-Aided Process Planning (CAPP).	4	6	16

Unit 5

PROCESS CONTROL AND DATA ANALYSIS

Introduction to process model formulation - linear feedback control systems - Optimal control - Adaptive control -Sequence control and PLC& SCADA. Computer process control - Computer process interface - Interface hardware - Computer process monitoring - Direct digital control and Supervisory computer control - Overview of Automatic identification methods - Bar code technology -Automatic data capture technologies.- Quality management (SPC) and automated inspection

Q.No	Question	CO	BTL	Marks
	Part A			
1.	Define process model formulation and its importance in control systems.	5	1	2
2.	What is a linear feedback control system? Give an example.	5	1	2
3.	List the advantages of optimal control in industrial processes.	5	1	2
4.	What are the main functions of a PLC (Programmable Logic Controller)?	5	1	2
5.	Explain the role of SCADA in industrial automation.	5	2	2
6.	What is Direct Digital Control (DDC)? How is it different from supervisory control?	5	1	2
7.	Define bar code technology and mention one industrial application.	5	1	2
8.	What is Statistical Process Control (SPC)? How does it improve quality?	5	1	2
	Part B			
1.	Case Study: A manufacturing plant wants to implement an adaptive control system to improve its production efficiency. • Explain the working principle of adaptive control. • What challenges might the plant face in implementing such a system? • Suggest a suitable control strategy for the plant.	5	4	16
2.	Compare Direct Digital Control (DDC) and Supervisory Control with examples.	5	4	16
3.	Explain how SPC (Statistical Process Control) is used in quality	5	5	16

	management with an example.			
4.	Explain the components and working of a Supervisory Computer Control system.	5	5	16

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CMR332
ADVANCED MANUFACTURING SYSTEMS

UNIT I

INTRODUCTION TO LEAN MANUFACTURING

Objectives of lean manufacturing-key principles and implications of lean manufacturing - traditional Vs lean manufacturing- flow-continuous improvement/Kaizen –worker involvement- 5S principles elements of JIT - uniform production rate - Kanban system - Lean implementation, Reconciling lean with other systems - lean six sigma- lean and ERP - lean with ISO 9001:2000.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What are the key objectives of lean manufacturing?	1	1	2
2.	List the five key principles of lean manufacturing.	1	1	2
3.	Differentiate between traditional manufacturing and lean manufacturing.	1	2	2
4.	What is Kaizen in lean manufacturing?	1	1	2
5.	What are the 5S principles in lean manufacturing?	1	1	2
6.	What is the role of the Kanban system in lean manufacturing?	1	1	2
7.	Define Just-In-Time (JIT) in the context of lean manufacturing.	1	1	2
8.	How does lean manufacturing integrate with ERP systems?	1	1	2
	PART B			
1.	Explain in detail the objectives, key principles, and implications of lean manufacturing.	1	2	16
2.	Compare and contrast traditional manufacturing with lean manufacturing.	1	2	16
3.	Discuss the concepts of Kaizen, 5S principles, and JIT, highlighting their role in achieving a uniform production rate.	1	2	16
4.	Analyze the implementation of lean manufacturing and its reconciliation with other systems like Lean Six Sigma, ERP, and ISO 9001:2000.	1	3	16

UNIT II

AGILE MANUFACTURING

Agile Manufacturing Vs Mass Manufacturing - Agile practice for product development - Manufacturing agile practices - Implementing new technology - A checklist, technology applications that enhance agility - agile technology make or buy decisions. - Costing for Agile Manufacturing practices.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is the primary difference between agile manufacturing and mass manufacturing?	2	2	2
2.	Define agile manufacturing.	2	1	2
3.	List two key practices for agile product development.	2	1	2
4.	What role does implementing new technology play in agile manufacturing?	2	1	2
5.	What is the significance of a checklist in implementing new technology for agile practices?	2	1	2
6.	Mention two examples of technology applications that enhance agility in manufacturing.	2	1	2
7.	What factors influence the make-or-buy decisions in agile manufacturing?	2	1	2
8.	How is costing different in agile manufacturing compared to traditional manufacturing?	2	1	2
	PART B			
1.	Compare and contrast agile manufacturing and mass manufacturing in detail.	2	2	16
2.	Explain agile practices for product development and manufacturing with suitable examples.	2	2	16
3.	Discuss the steps for implementing new technology in agile manufacturing.	2	2	16
4.	Analyze the cost considerations in agile manufacturing practices, including make-or-buy decisions.	2	4	16

UNIT III

SUSTAINABLE MANUFACTURING

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is a competitive strategy?	3	1	2
2.	How is manufacturing strategy linked to business success?	3	1	2
3.	What is a strategic improvement program?	3	1	2
4.	What are the key steps in structured strategy formulation?	3	1	2
5.	Define sustainable manufacturing system design.	3	1	2
6.	What are the options for designing a sustainable manufacturing system?	3	1	2
7.	What is the significance of strategy formulation approaches in manufacturing?	3	1	2
8.	What is meant by the realization of new strategies in manufacturing?	3	1	2
	PART B			
1.	Explain the concepts of competitive strategy and manufacturing strategies, and how to develop a strategic improvement program.	3	2	16
2.	Discuss the role of manufacturing strategy in business success and the process of strategy formation and formulation.	3	2	16
3.	Explore the design options for sustainable manufacturing systems and approaches to strategy formulation.	3	2	16
4.	Describe the process of realizing new strategies and system designs in manufacturing.	3	2	16

UNIT IV

INTELLIGENT MANUFACTURING

Introduction to intelligent manufacturing- fundamentals of artificial intelligence-AI in manufacturing processes- introduction to fuzzy logic-applications of fuzzy logic in manufacturing- integrating AI and fuzzy logic in production planning-real time decision making-case studies and practical application-emerging trends and future directions.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is intelligent manufacturing?	4	1	2
2.	What are the fundamentals of artificial intelligence (AI)?	4	1	2
3.	How is AI applied in manufacturing processes?	4	1	2
4.	What is fuzzy logic?	4	1	2
5.	Give two examples of applications of fuzzy logic in manufacturing.	4	1	2
6.	How does integrating AI and fuzzy logic improve production planning?	4	1	2
7.	What is the role of AI in real-time decision-making in manufacturing?	4	1	2
8.	Name and define one emerging trend in intelligent manufacturing.	4	1	2
	PART B			
1.	Explain the concept of intelligent manufacturing and discuss the fundamentals of AI in manufacturing processes.	4	2	16
2.	Discuss the role of fuzzy logic in manufacturing and its integration with AI in production planning.	4	2	16
3.	Analyze the importance of real-time decision-making in intelligent manufacturing, supported by case studies and practical applications.	4	4	16
4.	Explore the emerging trends and future directions in intelligent manufacturing.	4	2	16

UNIT V

SMART MANUFACTURING

Introduction to various Smart Manufacturing Techniques-Supply chain management-Block chain of inventory management-Plant digitization-Predictive maintenance-Supply chain visibility- Warehouse-Cost reduction-Waste management-Automated systems-Applications.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is smart manufacturing?	5	1	2
2.	How does supply chain management relate to smart manufacturing?	5	1	2
3.	What is the role of blockchain in inventory management?	5	1	2
4.	What is plant digitization in the context of smart manufacturing?	5	1	2
5.	What is predictive maintenance, and why is it important?	5	1	2
6.	What is supply chain visibility, and how does it benefit manufacturing?	5	1	2
7.	How do automated systems contribute to cost reduction?	5	1	2
8.	What is the role of waste management in smart manufacturing?	5	1	2
	PART B			
1.	Explain the various smart manufacturing techniques and their applications.	5	2	16
2.	Discuss the role of blockchain in inventory management and supply chain visibility.	5	2	16
3.	Analyze the impact of predictive maintenance and plant digitization on cost reduction and operational efficiency	5	4	16
4.	Explore the role of automated systems, waste management, and cost reduction in achieving smart manufacturing goals.	5	2	16

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CS3491
ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

UNIT I

PROBLEM SOLVING

Introduction to AI - AI Applications - Problem solving agents – search algorithms – uninformed search strategies – Heuristic search strategies – Local search and optimization problems – adversarial search – constraint satisfaction problems (CSP)

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is Artificial Intelligence?	1	1	2
2.	What are various applications of AI? or What can AI do today?	1	1	2
3.	What are the advantages of heuristic function?	1	1	2
4.	Is AI a science, or is it engineering? Or neither or both? Explain.	1	2	2
5.	How will you measure the problem-solving performance?	1	1	2
6.	State on which basis search algorithms are chosen?	1	1	2
7.	List some of the uninformed search techniques.	1	2	2
8.	What do you mean by local maxima with respect to search technique?	1	1	2
	PART B			
1.	Define the following problems. What types of control strategy is used in the following problem. i. The Tower of Hanoi ii. Crypto-arithmetic iii. The Missionaries and cannibals problems iv. 8-puzzle problem	1	4	16
2.	Explain the A* search and give the proof of optimality of A* Explain AO* algorithm with a suitable example. State the limitations in the algorithm?	1	4	8 8
3.	Explain the nature of heuristics with example. What is the effect of heuristics accuracy?	1	2	16
4.	Discuss about constraint satisfaction problem with a algorithm for solving a crypt arithmetic Problem. CROSS +ROADS ---------- DANGER ----------	1	2	16

UNIT II

PROBABILISTIC REASONING

Acting under uncertainty – Bayesian inference – naïve bayes models. Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define principle of maximum expected utility (MEU)	2	1	2
2.	Mention the needs of probabilistic reasoning in AI.	2	1	2
3.	State Bayes' Theorem in Artificial Intelligence.	2	1	2
4.	What is Bayesian Belief Network?	2	1	2
5.	Given that P(A)=0.3,P(A|B)=0.4 and P(B)=0.5, Compute P(B|A).	2	2	2
6.	Differentiate uncertainty with ignorance	2	2	2
7.	What is the need for utility theory in uncertainty?	2	1	2
8.	Why does uncertainty arise?	2	2	2
	PART B			
1.	Explain variable elimination algorithm for answering queries on Bayesian networks?	2	4	16
2.	Construct a Bayesian Network and define the necessary CPTs for the given scenario. We have a bag of three biased coins a,b and c with probabilities of coming up heads of 20%, 60% and 80% respectively. One coin is drawn randomly from the bag (with equal likelihood of drawing each of the three coins) and then the coin is flipped three times to generate the outcomes X1, X2 and X3. a. Draw a Bayesian network corresponding to this setup and define the relevant CPTs. b. Calculate which coin is most likely to have been drawn if the flips come up HHT	2	4	8 8
3.	Discuss about Bayesian Theory and Bayesian network.	2	2	16
4.	Explain how does Bayesian statistics provide reasoning under various kinds of uncertainty?	2	2	16

UNIT III

SUPERVISED LEARNING

Introduction to machine learning – Linear Regression Models: Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear ClassificationModels: Discriminant function – Probabilistic discriminative model - Logistic regression,Probabilistic generative model – Naive Bayes, Maximum margin classifier – Support vectormachine, Decision Tree, Random forests.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is Machine Learning?	3	1	2
2.	What is 'Over fitting' in Machine learning?	3	1	2
3.	What are the different Algorithm techniques in Machine Learning?	3	1	2
4.	What is the main key difference between supervised and unsupervised machine learning?	3	2	2
5.	What is 'Training set' and 'Test set'?	3	1	2
6.	What is a Linear Regression?	3	1	2
7.	Why is random forest better than SVM?	3	2	2
8.	What is the difference between stochastic gradient descent (SGD) and gradient descent (GD)?	3	1	2
	PART B			
1.	Explain Naïve Bayes Classifier with an Example.	3	4	16
2.	Explain the following a) Linear regression b) Logistic Regression	3	4	8 8
3.	Explain SVM Algorithm in Detail. Explain Decision Tree Classification.	3	2	8 8
4.	Explain the principle of the gradient descent algorithm. Accompany your explanation with a diagram. Explain the use of all the terms and constants that you introduce and comment on the range of values that they can take.	3	2	16

UNIT IV

ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING

Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is bagging and boosting in ensemble learning?	4	1	2
2.	What type of classifiers are used in weighted voting method?	4	1	2
3.	What are examples of unsupervised learning?	4	1	2
4.	What are Gaussian mixture models How is expectation maximization used in it?	4	2	2
5.	What is the principle of maximum likelihood?	4	1	2
6.	What is expectation maximization algorithm used for?	4	1	2
7.	How do you implement expectation maximization algorithm?	4	2	2
8.	What is the advantage of Gaussian process?	4	1	2
	PART B			
1.	List the applications of clustering and identify advantages and disadvantages of clustering algorithm.	4	4	16
2.	Explain various learning techniques involved in unsupervised learning?	4	4	16
3.	What is Gaussian process? And explain in detail of Gaussian parameter estimates with suitable examples.	4	2	16
4.	List non-parametric techniques and Explain K-nearest neighbour estimation.	4	2	16

UNIT V

NEURAL NETWORKS

Perceptron - Multilayer perceptron, activation functions, network training – gradientdescent optimization – stochastic gradient descent, error backpropagation, from shallownetworks to deep networks –Unit saturation (aka the vanishing gradient problem) – ReLU,hyperparameter tuning, batch normalization, regularization, dropout.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is perceptron and its types?	5	1	2
2.	What are the advantages of Multilayer Perceptron?	5	1	2
3.	What are the three main types gradient descent algorithm?	5	1	2
4.	Does stochastic gradient descent lead to faster training?	5	2	2
5.	What are the types of activation function?	5	1	2
6.	Why is ReLU used in deep learning?	5	2	2
7.	Is stochastic gradient descent same as gradient descent?	5	2	2
8.	What are the activation functions of MLP?	5	1	2
	PART B			
1.	List the factors that affect the performance of multilayer feed-forward neural network. Difference between a Shallow Net & Deep Learning Net.	5	4	8 8
2.	Develop a Back propagation algorithm for Multilayer Feed forward neural network consisting of one input layer, one hidden layer and output layer from first principles.	5	4	16
3.	Draw the architecture of a Multilayer perceptron (MLP) and explain its operation. Mention its advantages and disadvantages.	5	5	16
4.	Write the flowchart of error back-propagation training algorithm.	5	5	16

……THE END……

CMR356 - MICRO ELECTRO MECHANICAL SYSTEMS

UNIT I

AC CIRCUITS

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Polymers in MEMS– Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon				
Q.No	**Question**	**CO**	**BTL**	**Marks**
	PART A			
1.	What are the intrinsic characteristics of MEMS?	1	1	2
2.	What are the different energy domains used in MEMS?	1	1	2
3.	What is the role of transducers in MEMS?	1	1	2
4.	What is the difference between sensors and actuators in MEMS?	1	1	2
5.	What are the key steps involved in silicon-based MEMS fabrication?	1	1	2
6.	Name any two new materials used in MEMS fabrication.	1	1	2
7.	What are the advantages of using polymers in MEMS?	1	1	2
8.	What are the key properties of PDMS and its applications in MEMS?	1	1	2
	PART B			
1.	Explain the intrinsic characteristics of MEMS and discuss the various energy domains and transducers used in MEMS applications.	1	3	16
2.	Describe in detail the different types of sensors and actuators used in MEMS. Explain their working principles with suitable examples.	1	3	16
3.	Discuss the various silicon-based MEMS fabrication processes. How do new materials enhance MEMS performance and applications?	1	3	16
4.	Explain the role of polymers in MEMS. Compare and contrast different polymer materials such as Polyimide, SU-8, Liquid Crystal Polymer (LCP), PDMS, PMMA, Parylene, and Fluorocarbon in terms of properties and applications.	1	3	16

UNIT II

SENSORS

Characteristics of sensors - Electrostatic sensors – Parallel plate capacitors – Piezoresistive sensors – Piezoresistive sensor materials - Stress and strain analysis – Flexural beam bending - Torsional deflection– Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials				
Q.No	**Question**	**CO**	**BTL**	**Marks**
	PART A			
1.	What is the working principle of electrostatic sensors?	1	1	2
2.	How do parallel plate capacitors function as electrostatic sensors?	1	1	2
3.	Define piezoresistive sensors and their principle of operation.	1	1	2
4.	What are the typical materials used in piezoresistive sensors?	1	1	2
5.	Explain the concept of stress and strain in relation to sensor performance.	1	1	2
6.	What is the principle of flexural beam bending in sensor applications?	1	1	2
7.	Describe torsional deflection and its significance in sensor technology.	1	1	2
8.	What are the key applications of piezoelectric sensors and actuators?	1	1	2
	PART B			
1.	Discuss the working principle of electrostatic sensors with a focus on parallel plate capacitors. Explain their advantages, limitations, and applications in various sensor technologies.	1	3	16
2.	Explain the concept of piezoresistive sensors in detail. Discuss the materials commonly used in piezoresistive sensors, their properties, and how stress and strain analysis are integral to their operation. Include applications of piezoresistive sensors in pressure, flow, and tactile sensing.	1	3	16
3.	Provide an in-depth analysis of piezoelectric sensors and actuators, explaining the piezoelectric effects, materials used, and their operating principles. Discuss the various applications of piezoelectric sensors in fields like inertial sensing, pressure monitoring, and flow measurement.	1	3	16
4.	Discuss the principles of flexural beam bending and torsional deflection in sensor applications. Provide a detailed explanation of their relevance in designing sensors for measuring mechanical stress and strain, and how these phenomena are applied in practical sensor systems.	1	3	16

UNIT III

ACTUATORS

Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors - Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications –Magnetic Actuators – Micromagnetic components – Case studies of MEMS in magnetic actuators -Actuation using Shape Memory Alloys

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is the principle of operation of an interdigitated finger capacitor and its applications in MEMS?	1	1	2
2.	Explain the working mechanism of a comb drive device and its uses in microactuators.	1	1	2
3.	Describe the function of micro grippers in MEMS and give an example of their application.	1	1	2
4.	How do micro motors operate in MEMS technology and what are their typical applications?	1	1	2
5.	What is thermal sensing and actuation, and how does thermal expansion play a role in these processes?	1	1	2
6.	Explain the working principle of a thermocouple and its application in temperature sensing.	1	1	2
7.	What is a thermal bimorph, and how is it used in MEMS devices for actuation?	1	1	2
8.	Discuss the concept of magnetic actuators and their applications, particularly in MEMS technology.	1	1	2
	PART B			
1.	Explain the working principles of interdigitated finger capacitors and comb drive devices in MEMS technology. Discuss their applications in microactuators and sensing systems, highlighting the advantages and limitations of each.	1	3	16
2.	Discuss the different types of microactuators, such as micro grippers and micro motors, in MEMS. Provide detailed explanations of their working principles, applications, and how they are used in fields such as robotics, medical devices, and manufacturing.	1	3	16
3.	Describe the principles of thermal sensing and actuation in MEMS. Discuss the role of thermal expansion, thermocouples, thermal resistors, and thermal bimorphs in temperature sensing and actuation applications, with real-	1	3	16

	world examples.			
4.	Analyze the role of magnetic actuators and micro magnetic components in MEMS. Discuss various case studies where magnetic actuators have been successfully implemented, and describe how shape memory alloys (SMAs) are used in actuation, including their advantages in MEMS applications.	1	3	16

UNIT IV

MICROMACHINING

Silicon Anisotropic Etching – Anisotropic Wet Etching – Dry Etching of Silicon – Plasma Etching– Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies - Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Antirestriction methods – LIGA Process - Assembly of 3D MEMS – Foundry process.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is anisotropic wet etching of silicon?	1	1	2
2.	How does deep reactive ion etching (DRIE) differ from conventional plasma etching?	1	1	2
3.	What are gas phase etchants, and where are they used in MEMS fabrication?	1	1	2
4.	What is the role of sacrificial materials in surface micromachining?	1	1	2
5.	How does the LIGA process enable high-aspect-ratio microstructures?	1	1	2
6.	What is striction in MEMS, and how can it be prevented?	1	1	2
7.	What are the key advantages of isotropic wet etching over anisotropic etching?	1	1	2
8.	What are the main steps involved in the assembly of 3D MEMS devices?	1	1	2
	PART B			
1.	Explain in detail the different types of silicon etching techniques, including anisotropic wet etching, isotropic wet etching, dry etching, and deep reactive ion etching (DRIE). Compare their advantages and applications.	1	3	16

2.	Describe the LIGA process in MEMS fabrication. Discuss its key steps, advantages, and applications in high-aspect-ratio microstructures.	1	3	16
3.	Explain the basic surface micromachining processes, including the selection of structural and sacrificial materials. Discuss the acceleration of sacrificial etching and methods to prevent striction.	1	3	16
4.	Describe the MEMS foundry process and explain the steps involved in the assembly of 3D MEMS structures. Provide relevant case studies to support your explanation.	1	3	16

UNIT V

APPLICATIONS OF MEMS INERTIAL SENSORS

Application to Acceleration, Inertia, Acoustic, Tactile, Pressure, Flow and Tactile sensors- Optical MEMS –Lenses and Mirrors -Actuators for Active Optical MEMS.– RF MEMS and Microfluidics.				
Q.No	**Question**	**CO**	**BTL**	**Marks**
PART A				
1.	What is the role of acceleration sensors in MEMS applications?	1	1	2
2.	How do inertia-based MEMS sensors function?	1	1	2
3.	What is the working principle of an acoustic sensor in MEMS?	1	1	2
4.	Define a tactile sensor and mention one of its key applications.	1	1	2
5.	What are Optical MEMS, and how are they used in modern applications?	1	1	2
6.	How do RF MEMS differ from traditional RF components?	1	1	2
7.	What is the significance of microfluidics in biomedical applications?	1	1	2
8.	What are the main functions of MEMS-based pressure sensors?	1	1	2

PART B				
1.	Explain the working principles and applications of different MEMS sensors, including acceleration, inertia, acoustic, tactile, pressure, and flow sensors. Compare their functionalities and significance in real-world applications.	1	3	16
2.	Describe Optical MEMS in detail, covering the design and working of MEMS-based lenses, mirrors, and actuators for active optical applications. Discuss their advantages and key applications.	1	3	16
3.	Explain RF MEMS technology, including its components, working principles, and applications. Compare RF MEMS with traditional RF technologies and discuss their impact on modern communication systems.	1	3	16
4.	Discuss the principles of microfluidics in MEMS, explaining its fabrication techniques, working mechanisms, and applications in biomedical, chemical, and industrial fields.	1	3	16

……THE END……

MX3089

INDUSTRIAL SAFETY

UNIT I SAFETY TERMINOLOGIES

Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators - lag Indicators - Flammability - Toxicity Time - weighted Average (TWA) - Threshold LimitValue (TLV) - Short Term Exposure Limit (STEL) - Immediately dangerous to life or health (IDLH) - acute and chronic Effects - Routes of Chemical Entry - Personnel Protective Equipment - Health and Safety Policy - Material Safety Data Sheet MSDS.

PART - A

Q.NO	QUESTION	CO	BTL	MARK
1.	Define the term "hazard."	1	1	2
2	Differentiate between lead and lag indicators with an example for each.	1	2	2
3.	Distinguish between flammability and toxicity.	1	2	2
4.	Define Time-Weighted Average	1	1	2
5.	Differentiate between acute and chronic effects with examples.	1	2	2
6.	Name the four primary routes of chemical entry into the body.	1	1	2
7.	What is the purpose of a Health and Safety Policy?	1	1	2
8.	How does an MSDS help in chemical safety management?	1	2	2
	PART - B			
1.	Explain the types of Hazard in detail.	1	2	16
2.	Analyze the effectiveness of the hierarchy of hazard control measures in reducing risks in a manufacturing plant with toxic fumes and rotating machinery.	1	4	16
3.	Analyze how acute and chronic effects influence the choice of safety measures in handling hazardous chemicals.	1	4	16

4	Evaluate the effectiveness of a health and safety policy in fostering a culture of safety in an organization.	1	5	16

UNIT II STANDARDS AND REGULATIONS

Indian Factories Act-1948 - Health - Safety- Hazardous materials and Welfare - ISO 45001:2018 health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998 – Hazard Identification and Risk Analysis - code of practice IS 15656:2006

PART - A

Q.NO	QUESTION	CO	BTL	MARK
1.	What is the primary objective of the Indian Factories Act, 1948?	2	1	2
2	Name two health provisions under the Indian Factories Act, 1948.	2	1	2
3.	What is the main objective of risk analysis?	2	1	2
4.	List two examples of hazardous materials commonly found in industries.	2	1	2
5.	How does ISO 45001:2018 differ from traditional safety practices?	2	2	2
6.	What is IS 14489:1998 related to?	2	1	2
7.	What is the role of HIRA in workplace safety?	2	1	2
8.	How does IS 15656:2006 contribute to industrial safety?	2	2	2
	PART - B			
1.	Explain the key provisions of the Indian Factories Act, 1948 relatedto health, safety, hazardous materials, and worker welfare. How do these provisions ensure a safe working environment?	2	4	16

2.	Discuss the key principles of ISO 45001:2018 and its role in occupational health and safety management. How does it help organizations improve workplace safety?	2	4	16
3.	What is the significance of IS 14489:1998 in occupational safety audits? Describe the steps involved in conducting a workplace safety audit as per this standard.	2	4	16
4	Develop a Hazard Identification and Risk Analysis (HIRA) framework based on IS 15656:2006 for a manufacturing plant. How would you implement risk control measures to minimize workplace hazards?	2	6	16

UNIT III SAFETY ACTIVITIES

Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment.

PART A

Q.NO	QUESTION	CO	BTL	MARK
1.	What is the primary function of a safety committee?	3	1	2
2	What are two responsibilities of a safety officer in an organization?	3	2	2
3.	How does a safety representative contribute to workplace safety?	3	2	2
4.	Give two examples of safety incentives used to encourage safe behavior	3	2	2
5.	What is the purpose of conducting a mock drill?	3	2	2
6.	What is the significance of safety posters in the workplace?	3	2	2
7.	What is meant by human error in workplace safety?	3	2	2

8.	Name two methods used to assess human error in industrial settings	3	2	2
	PART - B			
1.	Explain the structure and functions of a safety committee in an organization. How does it contribute to workplace safety?	3	4	16
2.	Discuss the importance of safety training programs in an industrial setting. How do safety incentives encourage a culture of safety?	3	5	16
3.	Design a comprehensive emergency action plan for an industrial plant, including both on-site and off-site measures. What challenges might arise during	3	6	16
	implementation?			
4	Analyze different types of human errors in the workplace. How can organizations assess and minimize the risk of human errors affecting safety?	3	4	16

UNIT – 4

WORKPLACE HEALTH AND SAFETY

Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety- Toxic gas Release

PART - A

Q.NO	QUESTION	CO	BTL	Marks
1.	State how prolonged exposure to high noise levels can affect human health.	4	2	2
2	Define particulate matter and give an example of its source.	4	2	2
3.	Identify two ergonomics solutions to prevent musculoskeletal disorders caused by improper lifting.	4	2	2

4.	Compare RULE and REBA in terms of their application in ergonomic risk assessment.	4	2	2
5.	Differentiate between an unsafe act and an unsafe condition with examples.	4	2	2
6.	State two safety measures to prevent crane related accidents on a construction site.	4	2	2
7.	Why grounding and insulation are essential to prevent electrical hazards in the workplace?	4	2	2
8	Name two toxic gases commonly released in industrial accidents and their primary health effects.	4	2	2
PART B				
1.	Discuss the various types of electrical hazards in the workplace. What precautions and safety measures should be taken to prevent electrical accidents?	4	2	16
2.	Illustrate how to apply REBA to identify and mitigate ergonomic risk in various job tasks.	4	3	16
3.	Explain the impact of improper sitting posture and incorrect lifting techniques on musculoskeletal health. Suggest ergonomic solutions to prevent such disorders.	4	2	16
4	What are the causes and consequences of toxic gas release in industries? Discuss control measures, emergency response strategies and the role of safety regulations in preventing such incidents.	4	2	16

UNIT V HAZARD IDENTIFICATION TECHNIQUES

Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment- Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment

PART - A				
Q.NO	**QUESTION**	**CO**	**BTL**	**MARK**
1.	What is Job Safety Analysis (JSA), and why is it important?	5	1	2
2	Define Preliminary Hazard Analysis (PHA) and mention its primary purpose.	5	1	2
3.	List two key objectives of Failure Mode and Effects Analysis (FMEA).	5	2	2
4.	How does a Hazard and Operability Study (HAZOP) help in process safety?	5	2	2
5.	Differentiate between Fault Tree Analysis (FTA) and Event Tree Analysis (ETA).	5	2	2
6.	Explain the purpose of Qualitative and Quantitative Risk Assessment in workplace safety	5	3	2
7.	How does Checklist Analysis contribute to hazard identification?	5	3	2
8.	Give an example of how Root Cause Analysis (RCA) can be used to prevent future accidents.	5	3	2
PART B				
1.	Describe the key principles of the Job Safety Analysis (JSA) process. What are the main steps involved, and how does this technique help in ensuring workplace safety? Provide examples of how JSA can be applied in different industries.	5	2	16
2.	Explain the importance of Failure Mode and Effects Analysis (FMEA) in the context of risk management. How does this method contribute to the identification of potential failures and the prevention of system breakdowns? Provide an example of how FMEA is used in a high-risk industry such as aerospace or manufacturing	5	3	16

3.	Apply the principles of Hazard and Operability Study (HAZOP) to analyze the potential risks involved in a chemical processing plant. How would you identify deviations in the process and suggest appropriate safeguards to prevent hazardous events? Discuss how the HAZOP process can be applied to ensure safety in complex industrial systems.	5	4	16
4	Design a comprehensive risk management plan for a construction project that involves multiple stakeholders and complex processes. Synthesize various risk assessment methods such as Fault Tree Analysis (FTA), Event Tree Analysis, and Root Cause Analysis to develop a holistic framework for identifying, analyzing, and mitigating risks. What strategies would you incorporate to ensure that safety and operational efficiency are maintained throughout the project lifecycle?	5	4	16

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