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Mid Term Examinations - October 2026

Date: 05/10/2026 **Time:** 11:45 AM - 01:15 PM

Course Code: CIT3413 **Course Name:** Industrial IoT (IIoT)

Semester: Seventh Semester **Max. Marks:** 50 **Weightage:** 50%

CO - Levels	CO1	CO2
Marks	46	44

PART A: Answer Following Questions. 10 M

Q.N.	Questions	M	CO	BT
1	Edge computing processes data close to the machine or device where it is generated instead of sending all data to the cloud. It provides faster response, lower latency and reduced bandwidth usage.	2	CO1	BT2
2	A Digital Twin is a virtual model of a physical machine, process or factory. It can be used for real-time monitoring, simulation, failure prediction and process optimization.	2	CO1	BT2
3	• Smart irrigation • Soil and weather monitoring	2	CO1	BT2
4	It processes and analyzes industrial data close to where it is generated, reducing the need to send all raw data to the cloud and helping reduce latency.	2	CO2	BT2
5	Real-time performance is the ability of an IIoT system to respond within the required time limit for an industrial application. Latency, throughput and determinism are important factors.	2	CO2	BT2

PART B : Answer Any 1 Following Questions. 10 M

Q.N.	Questions	M	CO	BT

ANSWER KEY

PTO (Please Turn Over)

6	Predictive maintenance is an important IIoT application where industrial data is continuously monitored to identify possible equipment failures before they occur. **Traditional maintenance** In traditional reactive maintenance: **Machine operates → Failure occurs → Production stops → Repair** This can result in: • Unplanned downtime • Emergency repair costs • Production loss • Reduced equipment availability **IIoT predictive maintenance** The IIoT approach is: **Sensors → Data collection → Edge processing → Analytics/AI → Failure prediction → Planned maintenance** **Step 1: Data Collection** Sensors continuously collect: • Temperature • Vibration • Current • Pressure **Step 2: Edge Processing** Edge devices can identify abnormal conditions close to the machine. **Step 3: Analytics** Historical and real-time data can be analyzed to identify patterns. **Step 4: Prediction** AI/ML models can estimate the possibility of equipment failure. **Step 5: Maintenance Action** Maintenance can be scheduled before catas	10	CO1	BT2

ANSWER KEY

7	Traditional industrial systems generally depend on manual monitoring, scheduled maintenance, paper records and isolated machines. IIoT introduces: • Automatic monitoring • Connected machines • Predictive maintenance • Digital records • Condition-based maintenance • Intelligent automation • Real-time decision-making • Cloud-based data storage **Traditional approach** **Manual monitoring → Fixed maintenance → Machine failure → Manual repair** **IIoT approach** **Sensors → Continuous monitoring → Analytics → Prediction → Planned action** **Manufacturing example** Traditional manufacturing may depend on periodic machine inspections. With IIoT: 1. Sensors continuously monitor the machine. 2. Data is transmitted to edge/platform systems. 3. Analytics identifies abnormal behavior. 4. A prediction is generated. 5. Maintenance personnel receive an alert. 6. Maintenance can be scheduled before failure. **Other examples** **Retail:** Manual inventory → RFID-based inventory tracking **Logistics:** Paper logging → GPS and real-time shipment tracking **Agriculture:** Flood irrigation → Precision smart irrigation **Energy:** Manual meter reading → Smart grid monitoring **Transportation:** Fixed routes → Dynamic route optimization Thus, IIoT transforms industrial operations from reactive and manual processes into connected, intelligent and data-driven systems.	10	CO1	BT2

PART C: Answer Any 1 Following Questions. 10 M				
Q.N.	**Questions**	**M**	**CO**	**BT**

ANSWER KEY

8	These technologies work together to convert industrial data into useful decisions. **1. Edge Computing** Edge computing processes data close to the source. **Advantages:** • Fast response • Low latency • Reduced bandwidth • Local decision-making Example: An edge processor can immediately respond to dangerous machine temperature. **2. Cloud Computing** Cloud computing provides scalable storage and computing resources. It supports: • Large-scale data storage • Remote monitoring • Predictive maintenance • Production analytics • Dashboards **3. Big Data Analytics** Industrial machines generate huge volumes of data. Big Data analytics identifies useful patterns from this data. Applications include: • Pattern detection • Production optimization • Downtime reduction • Quality improvement • Failure forecasting **4. Artificial Intelligence and Machine Learning** AI/ML enables intelligent decision-making. Applications include: • Predictive maintenance • Quality inspection • Anomaly detection • Demand forecasting • Process optimization **Integrated operation** **Sensors → Edge → Cloud/Platform → Big Data Analytics → AI/ML → Decision → Action** Edge computing handles time-sensitive processing, while cloud and analytics systems can handle large-scale historical and computational workloads.	10	CO1	BT2

ANSWER KEY

IAF stands for **Industrial Internet Architecture Framework**.
It is a structured framework for designing and describing Industrial Internet systems.
IIAF helps identify:
• System components
• Relationships between components
• Data and information flows
• Stakeholder requirements
• Security concerns
• Operational concerns

Purpose of IIAF

The major purposes are:
1. Describe system architecture
2. Address stakeholder concerns
3. Improve communication
4. Support system design
5. Analyze architecture
6. Identify risks and requirements
7. Support scalability and interoperability
8. Support system lifecycle management

9 **IIAF vs IIoT Reference Architecture** — 10 — CO1 — BT2

Aspect	IIAF	IIoT Reference Architecture
Purpose	Framework/methodology for architecture development	Generic structure for IIoT systems
Focus	How to analyze and design architecture	What components/layers an IIoT system contains
Nature	Architecture framework	Reference model/architecture
Stakeholders	Strong emphasis on stakeholders and concerns	More focused on technical components and layers
Architecture representation	Viewpoints and views	Layers such as device, network, edge and enterprise
Scope	Broader industrial systems	More specifically focused on IIoT

Therefore, IIAF provides a broader architectural method, whereas the IIoT Reference Architecture provides a practical blueprint of the components and layers of an IIoT solution.

PART D: Answer Any 1 Following Questions. 10 M

Q.N.	Questions	M	CO	BT

ANSWER KEY

10	The three-tier architecture organizes industrial data processing into different levels. **Edge Tier** The Edge tier receives data directly from industrial devices. It performs: • Data collection • Aggregation • Local processing • Control • Protocol translation Example: A temperature sensor detects a high motor temperature. **Platform Tier** The platform receives the edge data. Its operations include: 1. Ingest 2. Transform 3. Process 4. Store 5. Analyze For example: **Raw vibration values → Normalized data → Anomaly detection** The platform can generate: • Events • Alerts • Trends • Commands • Data services **Enterprise Tier** The enterprise tier converts processed information into business and operational decisions. It provides: • Dashboards • User interfaces • Decision support • Application rules • ERP integration **Complete flow:** **Sensor → Edge → Platform → Enterprise** And the reverse direction may carry: **Commands → Configuration → Control feedback** **Example:** **Vibration rises** ↓ **Edge collects data** ↓ **Platform analyzes condition** ↓ **Enterprise creates maintenance action** ↓ **Operations respond** Thus, IIoT is a two-way data and control loop rather than simply a one-way sensor-to-cloud system.	10	CO2	BT2

ANSWER KEY

11	Consider a smart manufacturing line where machine condition must be continuously monitored. **1. Physical/Device Layer** The manufacturing machines contain: • Temperature sensors • Vibration sensors • Pressure sensors • PLCs • Motors • Actuators These devices collect operational data. **2. Connectivity Layer** The collected information is transferred through industrial communication networks. The network connects: **Devices → Gateway → Edge/Platform** **3. Edge/Fog Layer** The edge system processes data close to the machines. It can: • Filter data • Aggregate data • Detect abnormal conditions • Perform local control This reduces latency and unnecessary data transmission. **4. Data/Platform Layer** The platform receives and manages industrial data. It can: • Store historical information • Transform data • Run analytics • Detect patterns • Generate alerts **5. Application/Service Layer** The processed information is presented through: • Machine monitoring dashboards • Predictive maintenance applications • Quality monitoring • Production monitoring **6. Business/Enterprise Layer** Business systems use the information for: • Maintenance planning • Production planning • ERP integration • Management reporting • Business decisions **Example flow:** **Motor vibration increases** ↓ **Sensor detects vibration** ↓ **Edge gateway collects and filters data** ↓ **Platform analyzes the vibration trend** ↓ **Predictive maintenance application identifies possible failure** ↓ **Enterprise system creates maintenance action** ↓ **Maintenance team responds** This demonstrates how all six architectural layers cooperate to transform raw machine data into operational and business value.	10	CO2	BT2

ANSWER KEY

PART E: Answer Any 1 Following Questions. 10 M				
Q.N.	**Questions**	**M**	**CO**	**BT**
12	The first two layers of IIoT architecture are responsible for sensing the physical environment and communicating the collected information. **1. Physical/Device Layer** This layer contains physical industrial equipment that senses, generates, collects or acts on data. Major components include: • Sensors • Actuators • PLCs • Motors • Machines • Robots • Cameras • RFID devices **Functions:** • Sense physical conditions • Generate operational data • Perform physical actions • Control industrial equipment **2. Connectivity/Network Layer** This layer provides communication between devices, gateways, edge systems, cloud platforms and applications. It includes: • Ethernet • Wi-Fi • 4G/5G • Industrial networks • Routers • Switches • Gateways **Data flow:** **Sensors/Devices → Network → Gateway/Edge → Platform** The Physical layer therefore deals mainly with **sensing and actuation**, while the Connectivity layer provides **communication** between different components.	10	CO2	BT2

ANSWER KEY

13	These layers convert collected industrial data into useful information and services. **1. Data/Platform Layer** The Data/Platform Layer is responsible for: • Collecting data • Storing data • Managing data • Processing data • Providing data services Major components include: • Databases • Cloud platforms • Data lakes • Time-series databases • IoT platforms • APIs **2. Application/Service Layer** The Application/Service Layer converts processed data into useful industrial applications. Examples include: • Monitoring dashboards • Predictive maintenance • Production monitoring • Quality monitoring • Energy management • Asset tracking • Remote monitoring **Example** **Machine → Sensor → Edge → Data Platform → Predictive Maintenance Application** The platform manages the data, while the application layer presents the information in a form that operators, engineers and managers can use.	10	CO2	BT2

Q4. Explain the Business/Enterprise Layer of IIoT architecture with examples.

Answer:

The Business/Enterprise Layer is the upper layer of IIoT architecture. It uses industrial information to support business processes, planning, optimization and strategic decision-making.

Major components

• ERP
• MES
• Business Intelligence
• Supply Chain Management
• Management reports
• Business analytics

Functions

1. Business planning

IIoT information can support production and resource planning.

2. Decision-making

Managers can use dashboards and analytics to make data-driven decisions.

3. Enterprise integration

IIoT systems can connect factory-floor systems with ERP and MES.

4. Performance monitoring

Business users can monitor production, equipment and operational performance.

5. Optimization

Data can be used to optimize production, maintenance and resource utilization.

ANSWER KEY