BI – Unit 1 (Introduction to Decision Support Systems and Business Intelligence) - IN-SEM PYQ Answers

Q1. Define Business Intelligence. Explain Architecture of BI. [5]

Q2. Explain the main components of a business intelligence system with a suitable diagram. [5]

Q3. What are the different stages and benefits of Business Intelligence. [5]

Business Intelligence is a set of **processes, technologies, architectures and tools** used to collect, integrate, analyze and present business data to support **decision making**.

It transforms **raw data → information → knowledge** to improve strategic, tactical and operational decisions.

Architecture of Business Intelligence (BI Architecture):

A typical BI architecture consists of the following layers:

1. **Data Source Layer**
    - Operational databases (OLTP systems)
    - ERP, CRM systems
    - External data sources (web, market data)
    - Structured and semi-structured data
2. **Data Integration Layer (ETL)**
    - Extraction of data from multiple sources
    - Transformation (cleaning, standardization)
    - Loading into Data Warehouse
    - Ensures data consistency and quality
3. **Data Warehouse Layer**
    - Centralized repository of integrated data
    - Subject-oriented, time-variant, non-volatile
    - Stores historical data
    - Uses dimensional models (Star/Snowflake schema)
4. **OLAP Layer**
    - Online Analytical Processing
    - Multidimensional analysis
    - Operations: Drill-down, Roll-up, Slice, Dice
    - Supports fast query performance
5. **Presentation Layer**
    - Dashboards
    - Reports
    - Data visualization tools
    - Supports decision makers (DSS, EIS, MIS)

Simple BI Architecture Diagram (Text Form):

Data Sources → ETL → Data Warehouse → OLAP → Reports/Dashboards

OR

1. Data Source
   - The first step is gathering and consolidating data from an array of primary and secondary sources.
   - These sources vary in origin and format, consisting mainly of operational system data but also potentially containing unstructured documents like emails and data from external providers.

2. Data Mart / Data Warehouse
   - Through the utilization of extraction and transformation tools, also known as extract, transform, load (ETL).
   - data is acquired from various sources and saved in databases designed specifically for business intelligence analysis.
   - These databases, commonly known as data warehouses and data marts, serve as a centralized location for the gathered data.

3.Data Exploration
   - The third level of the pyramid offers essential resources for conducting a passive analysis in business intelligence.
   - These resources include query and reporting systems, along with statistical methods.
   - These techniques are referred to as passive because decision makers must first develop ideas or establish criteria for data extraction before utilizing analysis tools to uncover answers and confirm their initial theories.
   - For example, a sales manager might observe a decrease in revenues in a particular geographic region for a specific demographic of customers.
   - In response, she could utilize extraction and visualization tools to confirm her hypothesis and then use statistical testing to validate her findings based on the data.

4.Data Mining
   - The fourth level, known as active business intelligence methodologies, focuses on extracting valuable information and knowledge from data.
   - We will delve into various techniques such as mathematical models, pattern recognition, machine learning, and data mining.
   - Unlike the tools discussed in the previous level, active models do not rely on decision makers to come up with hypothesis but instead aim to enhance their understanding.

5.Optimization
   - As you ascend the pyramid, you'll encounter optimization models that empower you to choose the most optimal course of action among various alternatives, which can often be quite extensive or even endless.
   - These models have also been effectively incorporated in marketing and logistics.

6.Decisions
   - At last, the pinnacle of the pyramid reflects the ultimate decision made and put into action, serving as the logical end to the decision-making process.

- Despite the availability and effective utilization of business intelligence methodologies, the decision still lies in the hands of the decision makers, who can incorporate informal and unstructured information to fine-tune and revise the suggestions and outcomes generated by mathematical models.

Data Sources
↓
ETL Process
↓
Data Warehouse
↓
OLAP Server
↓
Reports / Dashboards / Visualization

Q4. What kind of ethics are required in business intelligence? Why? [5]

Business Intelligence deals with large volumes of organizational and customer data; therefore ethical practices are essential.

1. **Data Privacy Ethics**
   - Protect personal and sensitive information.
   - Avoid unauthorized access or misuse of customer data.
   - Required to maintain user trust and comply with data protection laws.
2. **Data Security Ethics**
   - Ensure confidentiality, integrity and availability of data.
   - Use access control, encryption and secure storage.
   - Prevent data breaches and cyber threats.
3. **Data Accuracy and Integrity**
   - Provide correct, validated and unbiased data.
   - Avoid manipulation or misrepresentation of reports.
   - Ensures reliable decision-making.
4. **Transparency and Accountability**
   - Clearly disclose data sources, assumptions and analytical methods.
   - Decision-makers must be accountable for BI-driven decisions.
   - Builds organizational credibility.
5. **Fairness and Non-Discrimination**
   - Avoid biased models or unfair profiling.
   - Ensure ethical use of analytics in HR, finance, marketing.
   - Prevents discriminatory business practices.

Why Ethics are Required in BI?

- BI supports strategic and financial decisions.
- Wrong or unethical use of data may cause financial loss, legal issues and reputational damage.
- Ensures responsible, lawful and trustworthy use of organizational data.

Hence, ethical principles are essential for sustainable and responsible Business Intelligence implementation.

Q5. Discuss the ethical problems that should not be overlooked during the adoption of business intelligence methodologies. [5]

During the adoption of Business Intelligence (BI) methodologies, several ethical issues must be carefully managed to ensure responsible use of data and maintain stakeholder trust:

1. **Privacy Violations**
    - Unauthorized collection, storage or use of personal data without consent.
    - Can lead to breaches of privacy rights and legal non-compliance (GDPR/CCPA).
    - Ethical BI requires informed consent and data minimization.
2. **Data Security and Confidentiality Risks**
    - Inadequate protection can expose sensitive information to unauthorized access or breaches.
    - Strong governance and secure controls are essential to protect organizational and customer data.
3. **Bias and Fairness Issues**
    - BI models can inherit biases from data, leading to unfair or discriminatory outcomes.
    - Unethical analysis can reinforce social inequalities or misrepresent groups.
4. **Lack of Transparency and Accountability**
    - Hidden or opaque data processing and decision mechanisms reduce trust.
    - Stakeholders must understand how BI decisions are derived and who is responsible.
5. **Data Manipulation and Misuse**
    - Altering or misrepresenting data to favor particular outcomes misleads decision makers.
    - Ensuring integrity and purpose limitation (using data only for intended goals) is necessary.

Why These Ethical Issues Matter

- Protect individual rights and organizational reputation
- Ensure legal compliance and reduce risk of penalties
- Build trust with customers, partners, and regulators
- Enable fair, accurate and responsible decision making in BI systems

Q6. What are the different stages and benefits of Business Intelligence? [5]

1. **Improved Decision-Making:** Timely and data-driven decisions based on accurate insights.
2. **Trend & Pattern Identification:** Detects customer behavior, market trends and operational inefficiencies.
3. **Operational Efficiency:** Optimizes business processes and resource allocation.
4. **Competitive Advantage:** Enables quicker response to changes in market or customer demand.
5. **Cost Reduction and Revenue Growth:** Helps identify cost-saving opportunities and new revenue streams.

Q7. Discuss the phases in the development of a decision support system.[5]

A Decision Support System development typically follows systematic stages similar to decision-making models and system development processes. The commonly accepted phases are:

1. **Planning Phase**
    - Identify the need for a DSS and define objectives.
    - Conduct feasibility analysis (Why build? Expected benefits, cost, time-frame).

- Establish scope, stakeholders and preliminary requirements.

2. **Analysis Phase**
   - Gather detailed requirements from decision-makers and end users.
   - Understand data sources, decision problems and information needs.
   - Analyze existing systems and determine data availability.

3. **Design Phase**
   - Define system architecture, data models, user interface and analytical tools.
   - Select software platforms, databases and modeling techniques.
   - Design reports, dashboards and interaction mechanisms.

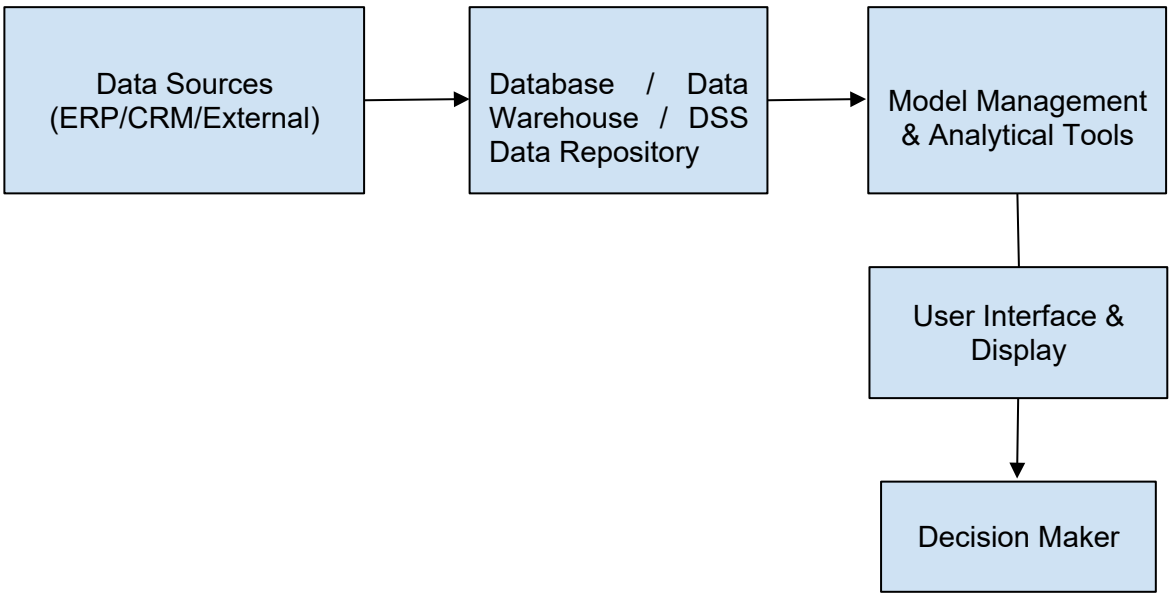
4. **Development/Implementation Phase**
   - Build and integrate components (data access, models, visualizations).
   - Program, test and validate the DSS functionality.
   - Iterative refinement based on user feedback.

5. **Deployment & Evaluation Phase**
   - Deploy the DSS to the operational environment.
   - Train users, monitor performance and collect feedback.
   - Maintain and update the system based on evolving needs.

Q8. Draw and explain schematic view of Decision Support System. [5]

A Decision Support System (DSS) is an interactive, computer-based information system that assists managers in solving **semi-structured and unstructured problems** using data, models, and analytics. It supports decision-making by integrating various components.

Schematic Block Diagram of DS



Explanation of Blocks

1. **Data Sources**
    - Internal systems (ERP, CRM, operational databases) and external sources.
    - Provide raw structured and unstructured data for analysis.
2. **Database / Data Repository**
    - Central storage of integrated and historical data (may include a data warehouse).
    - Supports querying and retrieval for analysis.
3. **Model Management & Analytical Tools**
    - Contains analytical, statistical, optimization and simulation models.
    - Applies models to data to generate insights, forecasts or alternative scenarios.
4. **User Interface & Presentation**
    - Interactive front-end for managers to input queries and view results.
    - Provides dashboards, reports, charts and visualization.
5. **Decision Maker**
    - The human user interprets the outputs and makes the final decision.
    - The system supports, but does not replace, managerial judgment.

How DSS Works

- Raw data flows from various **Data Sources** into the DSS **Database**.
- The **Model Management** subsystem applies analytical and decision models to this data.
- Results are presented via the **User Interface** to the **Decision Maker**, who uses insight to choose the best alternative.

Q9. What are several reasons for implementing a data warehouse separately from the databases supporting OLTP applications in an enterprise? [5]

In an enterprise, data warehouses are intentionally kept separate from operational (OLTP) systems because they serve different purposes and have distinct technical requirements:

1. **Different Workload Optimization**
    - OLTP systems are optimized for **fast, short transactional queries** (inserts/updates).
    - Data warehouses are optimized for **complex analytical queries** across large datasets.
    - Keeping them separate ensures each system performs efficiently without compromise.

2. **Avoiding Performance Impact on Operational Systems**
    - Running analytical queries on OLTP databases can slow down real-time transaction processing.
    - A separate warehouse prevents heavy BI queries from affecting business operations.

3. **Historical and Large-Scale Data Storage**
    - Data warehouses store **historical, aggregated data** from multiple sources for trend analysis.
    - OLTP systems typically hold only current transactional data.

4. **Data Integration from Multiple Sources**
    - Warehouse consolidates data from various operational systems (ERP, CRM).

- This integrated view supports enterprise-wide analysis that individual OLTP databases cannot provide.

5. **Different Data Models and Structures**
   - OLTP databases use **normalized schemas** to maintain consistency.
   - Data warehouses use **denormalized/multidimensional schemas** (star/snowflake) for fast analytical querying.
   - Separation allows appropriate schema design for analytics without affecting OLTP design.

Q10. Discuss the Cycle of a business intelligence analysis. [5]

The Business Intelligence (BI) analysis cycle is a **continuous iterative process** that transforms raw data into actionable insights to support decision making. It consists of sequential stages that move from understanding business needs to delivering insights in consumable formats.

1. **Analyze Business Requirements**
   - Identify the business problem, goals, and key performance indicators (KPIs).
   - Determines what data and insights are needed for decision making.
   - Aligns BI efforts with organizational objectives.
2. **Data Collection & Acquisition**
   - Gather relevant data from multiple internal (ERP, CRM) and external sources.
   - Raw data is sourced to provide a foundation for analysis.
   - Ensures completeness and relevance of input data.
3. **Data Processing/Preparation (ETL)**
   - Clean, transform and integrate collected data.
   - Remove inconsistencies, duplicates, and errors.
   - Prepare data for storage and analytic processing (ETL).
4. **Data Analysis**
   - Analyze processed data using analytical techniques (OLAP, statistical analysis, mining).
   - Identify patterns, trends and correlations relevant to business needs.
   - Provides meaningful insights from the data.
5. **Data Visualization & Reporting**
   - Present results through dashboards, charts, graphs, and reports.
   - Helps stakeholders interpret results easily.
   - Supports strategic and operational decision making.
6. **Decision Making & Feedback (Iterative)**
   - Business decisions are made based on insights produced.
   - Feedback from decisions refines the next BI cycle iteration.
   - Ensures continuous improvement in analytical accuracy.

Diagram:
Analyze Requirements → Data Collection → Data Processing (ETL) → Data Analysis → Visualization & Reporting → Decision Making (→ Feedback Loop)

This cycle ensures that BI efforts remain aligned with evolving business needs and continuously improve insights quality.

Q11. What are the advantages of making decision using business intelligence over making decision without business intelligence? [5]

Advantages of Making Decisions Using Business Intelligence over Without BI (5 Marks)

1. **More Informed and Accurate Decisions**
    - BI tools provide **real-time, validated data** with visual insights that reduce reliance on intuition or guesswork.
    - Decision makers can identify patterns, trends and correlations from data rather than incomplete information.
    - This leads to **better-informed strategic and operational decisions**.
2. **Faster Decision Making**
    - BI consolidates and analyses data quickly, enabling **timely decisions** when business conditions change.
    - Eliminates delays caused by manual data gathering or siloed data analysis.
    - Organizations can act immediately on insights.
3. **Improved Operational Efficiency**
    - BI identifies inefficiencies and bottlenecks across processes.
    - Insights support optimizing workflows and resource allocation.
    - Reduces costs and improves productivity.
4. **Better Customer and Market Understanding**
    - BI helps analyze customer behaviour, preferences, and market trends.
    - Businesses can tailor products, services and marketing strategies accordingly.
    - Enhances customer satisfaction and competitive position.
5. **Competitive Advantage and Strategic Insight**
    - BI provides a consolidated view of internal and external data, enabling proactive planning.
    - Organizations can anticipate opportunities and respond faster to competitors.
    - Supports long-term strategic goals and performance improvement.

Q12. Discuss the different types of decisions. [5]

Decisions in business can be classified based on **nature, structure and managerial level**. They help determine how problems are solved and what kind of support (like BI systems) is needed.

1. Structured Decisions

- These are **routine and repetitive** decisions with well-defined procedures.
- The process, inputs and outputs are known in advance (e.g., reorder inventory when stock falls below level).
- Can be automated with predefined rules.
- BI supports by delivering reliable data for automated processing.

2. Semi-structured Decisions

- Contains elements of both structured and unstructured decisions.
- Some components follow standard procedures while others require judgment.
- Often encountered in forecasting budgets or sales planning.
- DSS helps by combining data analysis with human judgment.

3. Unstructured Decisions

- Decisions with no clear procedure or algorithm.
- Unique, complex and require human intuition and experience (e.g., choosing a new market).
- BI systems assist by providing timely data and scenario insights, but human analysis dominates.

4. Strategic Decisions

- Long-term, high-impact decisions taken by senior management.
- Define direction and goals (e.g., new product launches, mergers).
- Require comprehensive analysis of data trends and external environment.

5. Tactical and Operational Decisions

- **Tactical Decisions:** Mid-level decisions translating strategic plans into specific actions (resource allocation, marketing strategies).
- **Operational Decisions:** Day-to-day decisions for routine operations (scheduling, order processing).
- Tactical decisions have medium time horizon; operational decisions are short-term and frequent.

Q13. Explain the representation of decision-making process with block diagram. [5]

Decision-making is a **systematic, step-by-step process** where managers or analysts identify a problem, evaluate alternatives, select the best option, implement it and review results. It converts data and analysis into action.

Block Diagram

Problem / Need Identification
↓
Data / Info Gathering
↓
Identify Possible Alternatives
↓
Evaluate Alternatives
↓
Select Best Alternative
↓
Implement Decision
↓
Monitor / Review Feedback
↓
(Repeat if needed)

1. **Problem / Need Identification**
    - Recognize and define the issue or opportunity where a decision is required.
    - Ensures the objective is clear and measurable.
2. **Data / Information Gathering**
    - Collect relevant internal and external data related to the problem.
    - BI systems and analytical tools are used to ensure quality information.
3. **Identify Possible Alternatives**

    - List all feasible options that could solve the problem.
    - Encourages creativity and breadth of choice.
4. **Evaluate Alternatives**
    - Analyze pros and cons of each alternative based on data, costs, risks and organizational objectives.
    - May use BI analytics or decision support tools.
5. **Select Best Alternative**
    - Choose the most suitable course of action with highest expected benefit.
    - Decision should align with organizational goals.
6. **Implement Decision**
    - Execute the chosen alternative through planned actions.
    - Allocate resources and responsibilities.
7. **Monitor / Review Feedback**
    - Track results and outcomes to ensure objectives are met.
    - If results are unsatisfactory, the process may loop back to earlier stages

Q14. State and explain with example stages of Simon's decision-making process. [5]

Herbert A. Simon proposed a systematic model of decision making that breaks down how decisions are made in organizations. The core stages describe how a problem is identified, alternatives are developed, and the most suitable course of action is selected.

1. Intelligence Phase

- **Definition:** Identify and understand the problem or opportunity.
- **Activities:** Scanning the environment, gathering relevant information, defining the decision situation.
- **Example:** A retail company notices a sudden drop in monthly sales and examines sales reports, customer feedback and inventory data to confirm the issue.
- **Purpose:** Establish a clear understanding of what needs to be solved.

2. Design Phase

- **Definition:** Generate and develop possible solutions or alternatives.
- **Activities:** Exploring different ways to address the identified problem, modeling potential solutions, estimating outcomes.
- **Example:** The retail team considers alternatives such as promotional discounts, revising product prices, or improving online marketing campaigns.
- **Purpose:** Create multiple feasible options for decision makers to evaluate.

3. Choice Phase

- **Definition:** Evaluate alternatives and select the best option.
- **Activities:** Comparing alternatives against criteria (cost, feasibility, impact), selecting the most appropriate one.
- **Example:** After analysis, the team decides that launching targeted online ads will likely boost sales most cost-effectively and chooses this option.
- **Purpose:** Make the actual decision on the course of action.

Q15. Explain role of mathematical models in BI. [5]

Mathematical models form the analytical core of Business Intelligence (BI) by converting raw data into structured insights that support **data-driven decision making**.

1. **Extracting Information and Knowledge**
    - BI uses mathematical models and algorithms to extract meaningful information and knowledge from large datasets.
    - Models help quantify relationships among variables, metrics and performance indicators.
    - Example: Using regression to determine how price changes affect sales volume.
2. **Evaluating Alternatives (What-If Analysis)**
    - Models enable simulation of different scenarios and assessment of their outcomes.
    - Decision makers can perform **what-if analysis** to compare possible strategies before implementation.
    - Example: Testing how a 10% budget increase impacts profitability under different cost assumptions.
3. **Supporting Structured Analytical Procedures**
    - Mathematical models provide a **rational and logical framework** for analysis, reducing subjective judgments.
    - They encourage systematic evaluation rather than ad-hoc decision making.
4. **Optimizing Decision Outcomes**
    - Models like optimization, linear programming or forecasting help identify **best solutions** under constraints.
    - Example: Determining optimal inventory levels to minimize holding costs while meeting demand.
5. **Enhancing BI Tools and Dashboards**
    - Advanced BI tools integrate mathematical models to generate predictive indicators (e.g., forecasts, risk scores).
    - This enhances dashboards with analytical depth beyond descriptive statistics.

Q16. Write a short note on data, information and knowledge with example.[5]

1. Data: Data are **raw, unprocessed facts and figures** collected from various sources. They have no meaning by themselves until processed or interpreted. Data may be numeric, textual, or symbolic.

Characteristics:

- Unorganized and context-free
- Collected from operational systems, sensors, transactions, logs
- Cannot directly support decision making

Example:
A retail store records daily sales as:
120, 85, 143, 97, 110
These numbers are **data points** showing units sold on different days but without context.

Exam Keyword Phrases:

- Raw facts and figures
- No inherent meaning
- Inputs for processing

2. Information: Information is **processed data that is organized and structured** to have meaning and usefulness for decision making. Information answers questions like *who, what, when, where*.

Characteristics:

- Processed and contextualized
- Useful for understanding trends and patterns
- Enables partial insight, supports operational decisions

Example:
From the sales data:
"Average units sold per day last week = 111 units"
This statement is **information** because data were processed (averaged) to provide meaning.

Exam Keyword Phrases:

- Processed data
- Contextualized and meaningful
- Used for operational decision support

3. Knowledge: Knowledge is **insights, understanding and experience derived from information** through analysis, reasoning, and interpretation. It supports *why* and *how* decisions should be made.

Characteristics:

- Application of experience + information
- Enables prediction and judgment
- Supports strategic decision making

Example:
"Sales typically increase by 25 % when promotional discounts are offered during festivals."
This insight is **knowledge** because it links patterns (from information) with business behavior and judgment.

Exam Keyword Phrases:

- Insights from information
- Experience + analytics
- Basis for strategic decisions

Comparison

Aspect	Data	Information	Knowledge
Nature	Raw, unprocessed	Processed, structured	Interpreted, actionable
Purpose	Input	Helps understanding	Informs decisions
Example	Sales numbers	Average sales	Insight into sales behavior