UNIT-5

An **Expert System** is a type of **Artificial Intelligence (AI) program** that is designed to **think and make decisions like a human expert** in a specific field.

It does **not think like a normal human**, but it uses **stored knowledge and logical rules** to solve complex problems.

Simple Definition:

An Expert System is a computer system that uses knowledge and reasoning to solve problems that normally require human expertise.

These systems are widely used in fields like:

- Medical diagnosis
- Banking
- Engineering
- Customer support
- Agriculture
- Education

Main Components of an Expert System

An expert system is made of three main parts:

1. Knowledge Base

It stores all the facts and expert information.

Example:

- In a medical expert system, it stores:
    - Symptoms
    - Diseases
    - Treatments

2. Inference Engine

This is the **brain** of the expert system.

It applies logical rules to the knowledge base to make decisions.

Example:

- If fever + cough → Maybe flu

3. User Interface

This allows a user to interact with the system.

The user enters:

- Questions
- Symptoms
- Problems

And the system gives solutions.

How Does an Expert System Work?

Step by step working:

1. User enters the problem.
2. The system searches the knowledge base.
3. Inference engine applies logical rules.
4. System gives a solution or advice.

Real-Life Example of an Expert System

Example 1: Medical Diagnosis System

Let's say you use a medical expert system.

User Input:

- Fever
- Headache
- Body pain

System Process:

- Matches these symptoms with stored diseases.

System Output:

You may have viral fever. Please consult a doctor.

Example 2: Car Troubleshooting Expert System

Problem: Your car doesn't start.

The system will ask:

- Is the battery light on?
- Is the engine making noise?

Based on answers, it might say:

Battery might be dead. Please replace or recharge it.

Characteristics of an Expert System

An expert system is:

✅ Knowledge-based
✅ Can explain its reasoning
✅ Reliable in specific domains
✅ Fast in problem-solving
✅ Works like a human expert in one field

Advantages of Expert Systems

- Available 24/7
- Reduces human errors
- Saves time and cost
- Useful in remote areas
- Helps in training new learners

APPLICATION

Applications of AI in Expert Systems (In English)

Expert Systems use Artificial Intelligence (AI) to solve complex problems. Here are the main applications (uses) of AI in Expert Systems:

1. Medical Diagnosis

AI-based expert systems are used in hospitals to:

- Identify diseases
- Analyze symptoms
- Suggest treatments

Example:
A system that checks fever, cough, and chest pain and suggests possible diseases.

2. Business and Finance

Expert systems help in:

- Loan approval
- Risk analysis
- Fraud detection
- Investment advice

Example:
AI system checks customer's financial details and decides loan eligibility.

3. Customer Support Systems

Used in:

- Chatbots
- Help desks
- Technical support

Example:
An AI chatbot that answers customer questions and solves basic problems.

4. Manufacturing and Industry

Used for:

- Fault detection in machines
- Quality control
- Process optimization

Example:
An expert system that finds defects in a production line.

5. Agriculture

AI expert systems help farmers by:

- Detecting plant diseases
- Suggesting fertilizers
- Predicting weather effects

Example:
AI system that tells the best time to sow seeds.

6. Education

Used for:

- Intelligent tutoring systems
- Virtual teachers
- Personalized learning

Example:
An AI system that gives practice questions based on student's weak areas.

7. Engineering and Technical Troubleshooting

Used to:

- Detect faults in electrical systems
- Troubleshoot computer or network problems

Example:
An AI expert system that tells why a computer is not starting.

8. Legal Advisory Systems

Used for:

- Case analysis
- Legal advice
- Document checking

Example:
AI system that helps lawyers find relevant legal cases.

9. Robotics

Used in:

- Decision-making
- Path planning
- Object recognition

Example:
Robots using AI expert systems to make smart decisions.

10. Military and Defense

Used for:

- Strategic planning
- Threat detection
- Surveillance

Example:
AI system that identifies suspicious activities using sensors.

EXINSTING EXPERT SYSTEM

1. MYCIN (Medical Expert System)

- Used for diagnosing bacterial infections.
- Suggests antibiotics and dosage.
- Developed at Stanford University.

2. DENDRAL (Chemical Analysis System)

- Used in chemistry to identify molecular structures.
- Helps scientists analyze chemical compounds.

3. XCON / R1 (Computer Configuration)

- Developed by DEC (Digital Equipment Corporation).
- Helps to configure computer systems automatically.
- Used in computer hardware companies.

4. PROSPECTOR (Mineral Exploration)

- Used in geology.
- Helps find mineral and ore deposits under the earth.

5. INTERNIST-I

- Medical expert system for internal diseases.
- Helps doctors in diagnosing complex diseases.

6. CADUCEUS

- Advanced version of INTERNIST-I.
- Used for medical diagnosis.

7. PXDES (Plant Disease Expert System)

- Used in agriculture.
- Helps detect plant diseases and pest problems.

8. DRILLING ADVISOR

- Used in oil and gas industry.
- Helps in drilling decisions and problem solving.

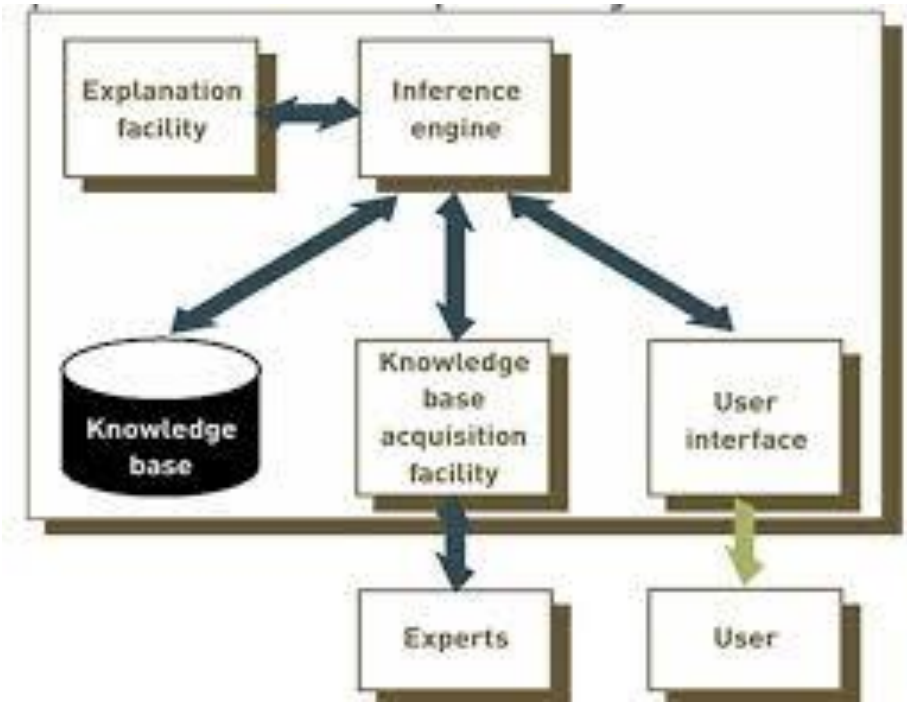
9. CLIPS (C Language Integrated Production System)

- A popular rule-based expert system tool.
- Used to build custom expert systems.

10. IBM Watson (Modern AI-based Expert System)

- Used in healthcare, business, and customer support.
- Helps in decision making and data analysis.

COMPONENTS OF TYPICAL EXPERT SYSTEM



1. Knowledge Base

This is the heart of the expert system.

What it contains:

- Facts (basic information)
- Rules (IF–THEN statements)
- Heuristics (experience-based knowledge)

Example:
In a medical expert system:

- Facts: Fever, cough, body pain
- Rule: IF fever + cough THEN flu

Role:
Stores all expert-level knowledge that the system uses to solve problems.

2. Inference Engine

This is the brain of the system.

Functions:

- Applies rules to the given facts
- Uses logical reasoning to reach conclusions
- Decides which rule to apply and when

Types of reasoning:

- Forward chaining: Starts from facts → reaches conclusion
- Backward chaining: Starts from goal → checks supporting facts

Example:
User enters symptoms → Inference engine matches rules → System gives diagnosis.

3. User Interface

This is the communication medium between the user and the expert system.

Functions:

- Takes input (queries, symptoms, problems) from the user
- Displays output (solutions, advice, explanations)

Example:
A screen where a user types: “My car is not starting”
System replies: “Battery may be weak.”

4. Explanation Facility

This component tells the user how and why the system reached a decision.

Functions:

- Explains the reason behind the answer
- Increases user trust in the system

Example:
System says:
“You may have flu because you reported fever and cough.”

5. Knowledge Acquisition System

This part is used to collect, update, and improve the knowledge base.

Sources of knowledge:

- Human experts
- Books, research papers
- Real-world data

Role:

- Converts expert knowledge into rules and facts
- Keeps the system updated.

6. Working Memory (Fact Base)

This stores the temporary data related to the current problem.

Difference from Knowledge Base:

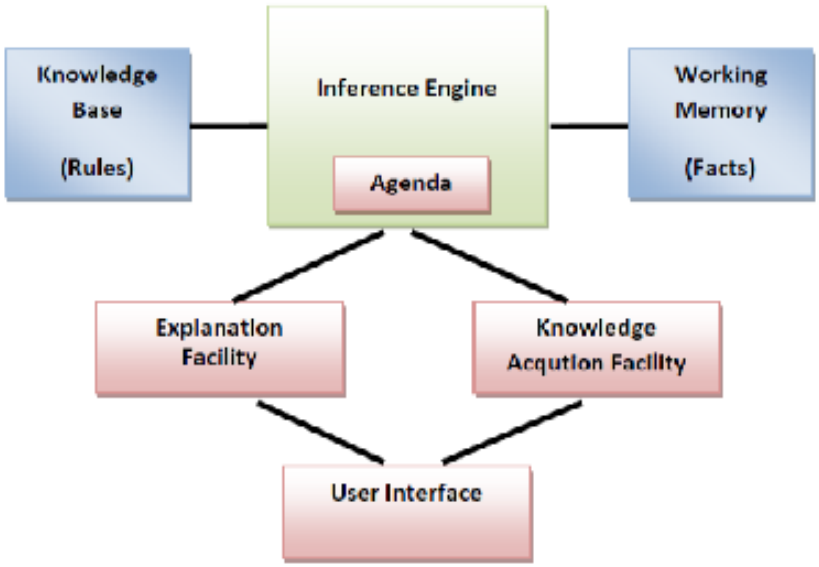
- Knowledge Base → Permanent, stored knowledge
- Working Memory → Temporary, current problem data

Example:
User's current symptoms are stored here during processing**.**

Flow of Working (How Components Work Together)

1. User enters problem through User Interface
2. Data goes to Working Memory
3. Inference Engine checks rules in Knowledge Base
4. System finds solution
5. Explanation Facility explains the result
6. Knowledge Acquisition System updates knowledge if required

RULE BASED SYSTEM ARCHITECTURE



A Rule-Based System is a type of Artificial Intelligence system that works using rules in the form of:

IF (condition) THEN (action)

Its architecture is the overall structure that shows how different parts of the system work together to solve a problem.

Main Components of Rule-Based System Architecture

1. Knowledge Base (Rule Base)

This is the core storage area of the system.

What it contains:

- Facts (basic information)
- Rules (IF–THEN rules)

Example of a rule:

IF temperature is high AND cough is present

THEN disease is flu

Function:

- Stores expert knowledge
- Stores decision-making rules

2. Working Memory (Fact Base)

This stores temporary data related to the current problem.

Contains:

- User's input
- Current facts during problem solving

Difference from Knowledge Base:

- Knowledge Base = Permanent knowledge
- Working Memory = Temporary, problem-specific data

3. Inference Engine

This is the brain of the rule-based system.

Main functions:

- Matches the rules with facts
- Selects appropriate rules
- Fires the selected rules
- Controls the reasoning process

Types of reasoning methods:

a) Forward Chaining (Data-Driven)

- Starts from given facts
- Applies rules
- Reaches a conclusion

b) Backward Chaining (Goal-Driven)

- Starts from a goal
- Looks for rules that support the goal
- Checks if facts satisfy the conditions

4. User Interface

Acts as the communication layer between user and system.

Functions:

- Takes input from user
- Displays output and recommendations

Example:
User enters:
“My car does not start”
System outputs:
“Battery may be weak.”

5. Explanation Facility

This component explains how and why the system made a decision.

Functions:

- Explains the reasoning steps
- Shows which rules were fired

Example output:
“I concluded this because rule 5 matched your symptoms.”

6. Knowledge Acquisition Module

Used for adding and updating knowledge in the system.

Sources of knowledge:

- Human experts
- Books and documents
- Databases

Functions:

- Converts expert knowledge into rules
- Updates the knowledge base

Architecture Flow (How the System Works Step by Step)

1. User enters problem through User Interface
2. Data is stored in Working Memory
3. Inference Engine checks facts in Working Memory
4. It matches rules stored in Knowledge Base
5. Suitable rule is selected and executed
6. Result is sent to the user
7. Explanation Facility shows reasoning
8. If needed, Knowledge Acquisition Module updates knowledge

Simple Architecture Diagram Explanation (In Words)

Flow of architecture:

User

↓

User Interface

↓

Working Memory ↔ Inference Engine ↔ Knowledge Base

↓

Explanation Facility

↓

User Output

And Knowledge Acquisition Module updates the Knowledge Base from time to time.

Advantages of Rule-Based System Architecture

- Easy to understand logic
- Transparent decision-making
- Easy to modify rules
- Good for expert-level problem solving

Limitations

- Slow when rules become very large
- Difficult to manage if too many rules exist
- Cannot learn automatically (without extra learning modules)