Unit-IV

Q.Differentiate between fault, error and failure.

Fault, Error and Failure

Fault: It is a condition that causes the software to fail to perform its required function.
Error: Refers to difference between Actual Output and Expected output.
Failure: It is the inability of a system or component to perform required function according to its specification.

IEEE Definitions

- **Failure:** External behavior is incorrect
- **Fault:** Discrepancy (unexpected **difference)** in code that causes a failure.
- **Error:** Human mistake that caused fault

Note:

- **Error** is terminology of Developer.
- **Bug** is terminology of Tester.

An error is something that a human does, we all make mistakes and when we do whilst developing software, it is known as an error. The result of an error being made is a fault. It is something that is wrong in the software (source code or documentation – specifications, manuals, etc.). Faults are also known as defects or bugs.
When a system or piece of software produces an incorrect result or does not perform the correct action, this is known as a failure. Failures are caused by faults in the software. Note that software system can contain faults but still never fail (this can occur if the faults are in those parts of the system that are never used). In other words, failure is the manifestation of one or more faults (bugs).

Q.Explain test case.

What is Test case?

A test case is a document, which has a set of test data, preconditions, expected results and post conditions, developed for a particular test scenario in order to verify compliance against a specific requirement.
Test Case acts as the starting point for the test execution, and after applying a set of input values, the application has a definitive outcome and leaves the system at some end point or also known as execution post condition.

Typical Test Case Parameters:

- Test Case ID
- Test Scenario
- Test Case Description
- Test Steps
- Prerequisite
- Test Data
- Expected Result
- Test Parameters
- Actual Result
- Environment Information
- Comments

Therefore, we would also like to minimize the number of test cases needed to detect errors. These are the two fundamental goals of a practical testing activity – maximize the number of errors detected and minimize the number of test cases. With selecting test cases the primary objectives is to ensure that if there is an error or fault in the program, it is exercised by one of the test cases. An ideal test case set is one that succeeds (meaning that its execution reveals no errors) only if there are no errors in the program. For this test selection criterion can be used. There are two aspects of test case selection – specifying a criterion for evaluating a set of test cases, and generating a set of test cases that satisfy a given criterion.

Q.Explain test criteria.

Test criteria

An ideal test case set is one that succeeds (meaning that its execution reveals no errors) only if there are no errors in the program. For this test selection criterion can be used. There are two aspects of test case selection – specifying a criterion for evaluating a set of test cases, and generating a set of test cases that satisfy a given criterion.

There are two fundamental properties for a testing criterion: **reliability and validity**. A criterion is reliable if all the sets that satisfy the criterion detect the same errors. A criterion is valid if for any error in the program there is some set satisfying the criterion that will reveal the error. Some axioms capturing some of the desirable properties of test criteria have been proposed. The first axiom is the applicability axiom, which states that for every program there exists a test set T that satisfies the criterion.

This is clearly desirable for a general-purpose criterion: a criterion that can be satisfied only for some types of programs is of limited use in testing. The anti extensionality axiom states that there are programs P and Q, both of which implement the same specifications, such that a test set T satisfies the criterion for P but does not satisfy the criterion for Q. This axiom ensures that the program structure has an important role to play in deciding the test cases.

Q.Explain software testing.

Software Testing

Testing is the process of evaluating a system or its component(s) with the intent to find whether it satisfies the specified requirements or not.

Testing is executing a system in order to identify any gaps, errors, or missing requirements in contrary to the actual requirements.

Software Testing - Types of Testing

1.Manual Testing

Manual testing includes testing a software manually, i.e., without using any automated tool or any script. In this type, the tester takes over the role of an end-user and tests the software to identify any unexpected behavior or bug. There are different stages for manual testing such as unit testing, integration testing, system testing, and user acceptance testing.

Testers use test plans, test cases, or test scenarios to test a software to ensure the completeness of testing. Manual testing also includes exploratory testing, as testers explore the software to identify errors in it.

2.Automation Testing

Automation testing, which is also known as Test Automation, is when the tester writes scripts and uses another software to test the product. This process involves automation of a manual process. Automation Testing is used to re-run the test scenarios that were performed manually, quickly, and repeatedly.

Q.Explain test strategy.
What is Test Strategy?

Test Strategy is also known as test approach defines how testing would be carried out. Test approach has two techniques:

- **Proactive -** An approach in which the test design process is initiated as early as possible in order to find and fix the defects before the build is created.
- **Reactive -** An approach in which the testing is not started until after design and coding are completed.

Software Testing V-Model

The V-model is an SDLC model where execution of processes happens in a sequential manner in a V-shape. It is also known as **Verification and Validation model**.

The V-Model is an extension of the waterfall model and is based on the association of a testing phase for each corresponding development stage. This means that for every single phase in the development cycle, there is a directly associated testing phase. This is a highly-disciplined model and the next phase starts only after completion of the previous phase.

V-Model - Design

Under the V-Model, the corresponding testing phase of the development phase is planned in parallel. So, there are Verification phases on one side of the 'V' and Validation phases on the other side. The Coding Phase joins the two sides of the V-Model.

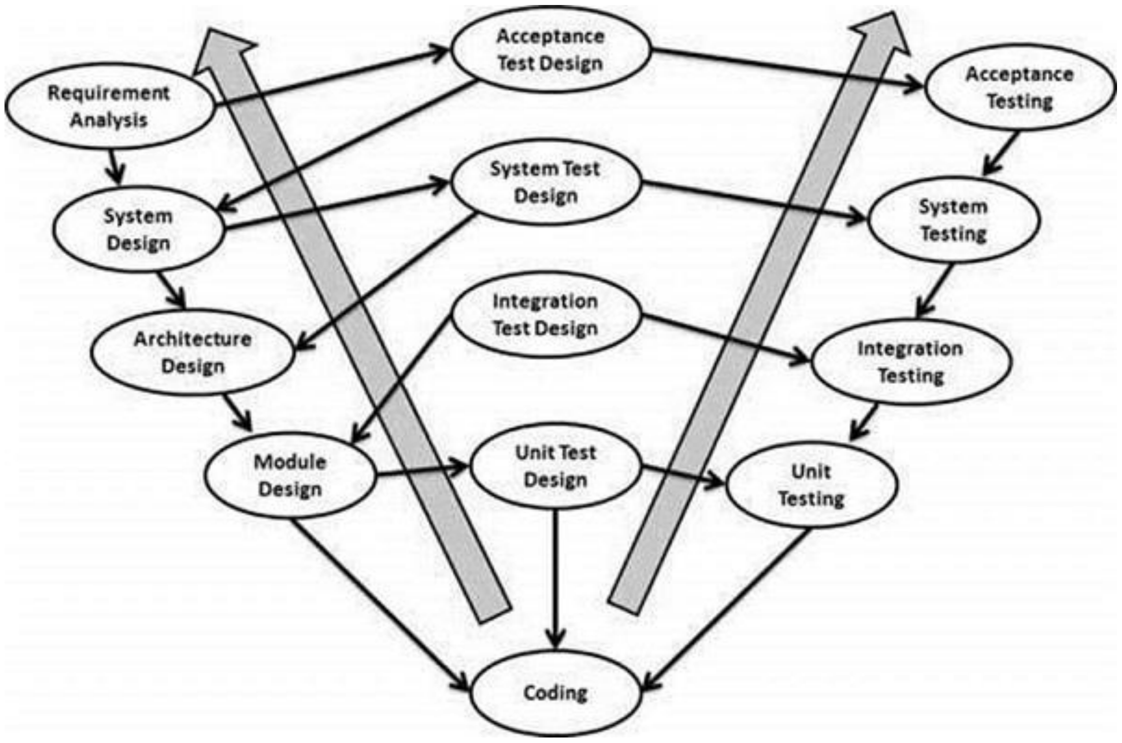
The following illustration depicts the different phases in a V-Model of the SDLC.

V-Model - Verification Phases

There are several Verification phases in the V-Model, each of these are explained in detail below.

Business Requirement Analysis

This is the first phase in the development cycle where the product requirements are understood from the customer's perspective. This phase involves detailed communication with the customer to understand his expectations and exact requirement. This is a very important activity and needs to be managed well, as most of the customers are not sure about what exactly they need. The **acceptance test design planning** is done at this stage as business requirements can be used as an input for acceptance testing.



System Design

Once you have the clear and detailed product requirements, it is time to design the complete system. The system design will have the understanding and detailing the complete hardware and communication setup for the product under development. The system test plan is developed based on the system design. Doing this at an earlier stage leaves more time for the actual test execution later.

Architectural Design

Architectural specifications are understood and designed in this phase. Usually more than one technical approach is proposed and based on the technical and financial feasibility the final decision is taken. The system design is broken down further into modules taking up different functionality. This is also referred to as **High Level Design (HLD)**.

The data transfer and communication between the internal modules and with the outside world (other systems) is clearly understood and defined in this stage. With this information, integration tests can be designed and documented during this stage.

Module Design

In this phase, the detailed internal design for all the system modules is specified, referred to as **Low Level Design (LLD)**. It is important that the design is compatible with the other modules in the system architecture and the other external systems. The unit tests are an essential part of any development process and helps eliminate the maximum faults and errors at a very early stage. These unit tests can be designed at this stage based on the internal module designs.

Coding Phase

The actual coding of the system modules designed in the design phase is taken up in the Coding phase. The best suitable programming language is decided based on the system and architectural requirements.
The coding is performed based on the coding guidelines and standards. The code goes through numerous code reviews and is optimized for best performance before the final build is checked into the repository.

Validation Phases

The different Validation Phases in a V-Model are explained in detail below.

Unit Testing

Unit tests designed in the module design phase are executed on the code during this validation phase. Unit testing is the testing at code level and helps eliminate bugs at an early stage, though all defects cannot be uncovered by unit testing.

Integration Testing

Integration testing is associated with the architectural design phase. Integration tests are performed to test the coexistence and communication of the internal modules within the system.

System Testing

System testing is directly associated with the system design phase. System tests check the entire system functionality and the communication of the system under development with external systems. Most of the software and hardware compatibility issues can be uncovered during this system test execution.

Acceptance Testing

Acceptance testing is associated with the business requirement analysis phase and involves testing the product in user environment. Acceptance tests uncover the compatibility issues with the other systems available in the user environment. It also discovers the non-functional issues such as load and performance defects in the actual user environment.

V- Model – Application

V- Model application is almost the same as the waterfall model, as both the models are of sequential type. Requirements have to be very clear before the project starts, because it is usually expensive to go back and make changes. This model is used in the medical development field, as it is strictly a disciplined domain.
The following pointers are some of the most suitable scenarios to use the V-Model application.

- Requirements are well defined, clearly documented and fixed.
- Product definition is stable.
- Technology is not dynamic and is well understood by the project team.
- There are no ambiguous or undefined requirements.
- The project is short.

V-Model - Pros and Cons

The advantage of the V-Model method is that it is very easy to understand and apply. The simplicity of this model also makes it easier to manage. The disadvantage is that the model is not flexible to changes and just in case there is a requirement change, which is very common in today's dynamic world, it becomes very expensive to make the change.

The advantages of the V-Model method are as follows –

- This is a highly-disciplined model and Phases are completed one at a time.
- Works well for smaller projects where requirements are very well understood.
- Simple and easy to understand and use.
- Easy to manage due to the rigidity of the model. Each phase has specific deliverables and a review process.

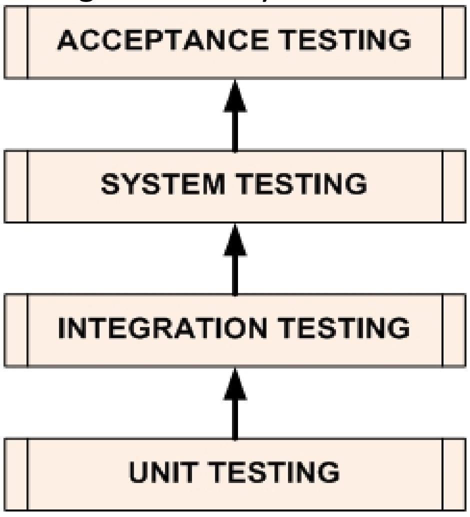
The disadvantages of the V-Model method are as follows –

- High risk and uncertainty.
- Not a good model for complex and object-oriented projects.
- Poor model for long and ongoing projects.
- Not suitable for the projects where requirements are at a moderate to high risk of changing.
- Once an application is in the testing stage, it is difficult to go back and change a functionality.

- No working software is produced until late during the life cycle.

Software Testing Levels

SOFTWARE TESTING LEVELS are the different stages of the software development lifecycle where testing is conducted. There are four levels of software testing: Unit >> Integration >> System >> Acceptance.



Level	**Summary**
Unit Testing	A level of the software testing process where individual units of software are tested. The purpose is to validate that each unit of the software performs as designed.
Integration Testing	A level of the software testing process where individual units are combined and tested as a group. The purpose of this level of testing is to expose faults in the interaction between integrated units.
System Testing	A level of the software testing process where a complete, integrated system is tested. The purpose of this test is to evaluate the system's compliance with the specified requirements.
Acceptance Testing	A level of the software testing process where a system is tested for acceptability. The purpose of this test is to evaluate the system's compliance with the business requirements and assess whether it is acceptable for delivery.

Q.Explain unit testing with proper example.

Unit Testing

This type of testing is performed by developers before the setup is handed over to the testing team to formally execute the test cases. Unit testing is performed by the respective developers on the individual units of source code assigned areas. The developers use test data that is different from the test data of the quality assurance team.
The goal of unit testing is to isolate each part of the program and show that individual parts are correct in terms of requirements and functionality.

Limitations of Unit Testing

Testing cannot catch each and every bug in an application. It is impossible to evaluate every execution path in every software application. The same is the case with unit testing.
There is a limit to the number of scenarios and test data that a developer can use to verify a source code. After having exhausted all the options, there is no choice but to stop unit testing and merge the code segment with other units.

Q.Explain integration testing with proper example.

Integration Testing

Integration testing is defined as the testing of combined parts of an application to determine if they function correctly. Integration testing can be done in two ways: Bottom-up integration testing and Top-down integration testing.

Sr.No.	Integration Testing Method
1	**Bottom-up integration** This testing begins with unit testing, followed by tests of progressively higher-level combinations of units called modules or builds.

2	**Top-down integration** In this testing, the highest-level modules are tested first and progressively, lower-level modules are tested thereafter.

In a comprehensive software development environment, bottom-up testing is usually done first, followed by top-down testing. The process concludes with multiple tests of the complete application, preferably in scenarios designed to mimic actual situations.

Q.Explain system testing

System Testing

System testing tests the system as a whole. Once all the components are integrated, the application as a whole is tested rigorously to see that it meets the specified Quality Standards. This type of testing is performed by a specialized testing team.
System testing is important because of the following reasons −

- System testing is the first step in the Software Development Life Cycle, where the application is tested as a whole.
- The application is tested thoroughly to verify that it meets the functional and technical specifications.
- The application is tested in an environment that is very close to the production environment where the application will be deployed.
- System testing enables us to test, verify, and validate both the business requirements as well as the application architecture.

Q.Explain regression testing.

Regression Testing

Whenever a change in a software application is made, it is quite possible that other areas within the application have been affected by this change. Regression testing is performed to verify that a fixed bug hasn't resulted in another functionality or business rule violation. The intent of regression testing is to ensure that a change, such as a bug fix should not result in another fault being uncovered in the application.
Regression testing is important because of the following reasons −

- Minimize the gaps in testing when an application with changes made has to be tested.
- Testing the new changes to verify that the changes made did not affect any other area of the application.
- Mitigates risks when regression testing is performed on the application.
- Test coverage is increased without compromising timelines.
- Increase speed to market the product.

Q.Explain acceptance testing.

Acceptance Testing

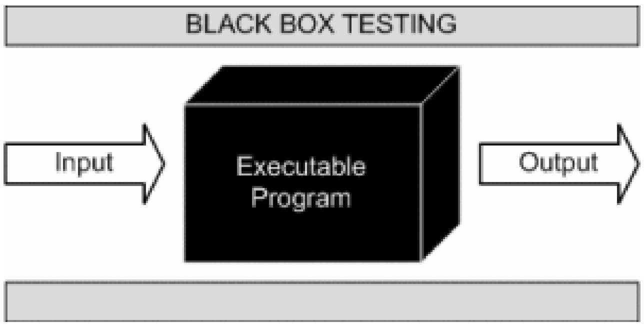
This is arguably the most important type of testing, as it is conducted by the Quality Assurance Team who will gauge whether the application meets the intended specifications and satisfies the client's requirement. The QA team will have a set of pre-written scenarios and test cases that will be used to test the application.
More ideas will be shared about the application and more tests can be performed on it to gauge its accuracy and the reasons why the project was initiated. Acceptance tests are not only intended to point out simple spelling mistakes, cosmetic errors, or interface gaps, but also to point out any bugs in the application that will result in system crashes or major errors in the application.
By performing acceptance tests on an application, the testing team will reduce how the application will perform in production. There are also legal and contractual requirements for acceptance of the system.

Testing Technique

Q.Explain black box testing with its advantages and disadvantages.

1] Black Box Testing

BLACK BOX TESTING, also known as Behavioral Testing is a software testing method in which the internal structure/design/implementation of the item being tested is not known to the tester. These tests can be functional or non-functional, though usually functional.



This method is named so because the software program, in the eyes of the tester, is like a black box; inside which one cannot see. This method attempts to find errors in the following categories:

- Incorrect or missing functions
- Interface errors
- Errors in data structures or external database access
- Behavior or performance errors
- Initialization and termination errors

Example

A tester, without knowledge of the internal structures of a website, tests the web pages by using a browser; providing inputs (clicks, keystrokes) and verifying the outputs against the expected outcome.

Levels Applicable To

Black Box testing method is applicable to the following levels of software testing:

- **Integration Testing**
- **System Testing**
- **Acceptance Testing**

The higher the level, and hence the bigger and more complex the box, the more black-box testing method comes into use.

Techniques

Following are some techniques that can be used for designing black box tests.

- *Equivalence Partitioning:* It is a software test design technique that involves dividing input values into valid and invalid partitions and selecting representative values from each partition as test data.
- *Boundary Value Analysis:* It is a software test design technique that involves the determination of boundaries for input values and selecting

values that are at the boundaries and just inside/ outside of the boundaries as test data.

- *Cause-Effect Graphing:* It is a software test design technique that involves identifying the cases (input conditions) and effects (output conditions), producing a Cause-Effect Graph, and generating test cases accordingly.

Advantages

- Tests are done from a user's point of view and will help in exposing discrepancies in the specifications.
- Tester need not know programming languages or how the software has been implemented.
- Tests can be conducted by a body independent from the developers, allowing for an objective perspective and the avoidance of developer-bias.
- Test cases can be designed as soon as the specifications are complete.

Disadvantages

- Only a small number of possible inputs can be tested and many program paths will be left untested.
- Without clear specifications, which is the situation in many projects, test cases will be difficult to design.
- Tests can be redundant if the software designer/developer has already run a test case.
- Ever wondered why a soothsayer closes the eyes when foretelling events? So is almost the case in Black Box Testing.

Black Box Testing is contrasted with White Box Testing.

Q.Explain white box testing with its advantages and disadvantages.

<u>2] White Box Testing</u>

WHITE BOX TESTING (also known as Clear Box Testing, Open Box Testing, Glass Box Testing, Transparent Box Testing, Code-Based Testing or Structural Testing) is a software testing method in which the internal structure/design/implementation of the item being tested is known to the tester. The tester chooses inputs to exercise paths through the code and determines the appropriate outputs. Programming know-how and the implementation knowledge is essential. White box testing is testing beyond the user interface and into the nitty-gritty of a system.
This method is named so because the software program, in the eyes of the tester, is like a white/transparent box; inside which one clearly sees.

Example

A tester, usually a developer as well, studies the implementation code of a certain field on a webpage, determines all legal (valid and invalid) AND illegal inputs and verifies the outputs against the expected outcomes, which is also determined by studying the implementation code.
White Box Testing is like the work of a mechanic who examines the engine to see why the car is not moving.
Levels Applicable To
White Box Testing method is applicable to the following levels of software testing:

- Unit Testing: For testing paths within a unit.
- Integration Testing: For testing paths between units.
- System Testing: For testing paths between subsystems.

However, it is mainly applied to Unit Testing.

Advantages

- Testing can be commenced at an earlier stage. One need not wait for the GUI to be available.
- Testing is more thorough, with the possibility of covering most paths.

Disadvantages

- Since tests can be very complex, highly skilled resources are required, with a thorough knowledge of programming and implementation.

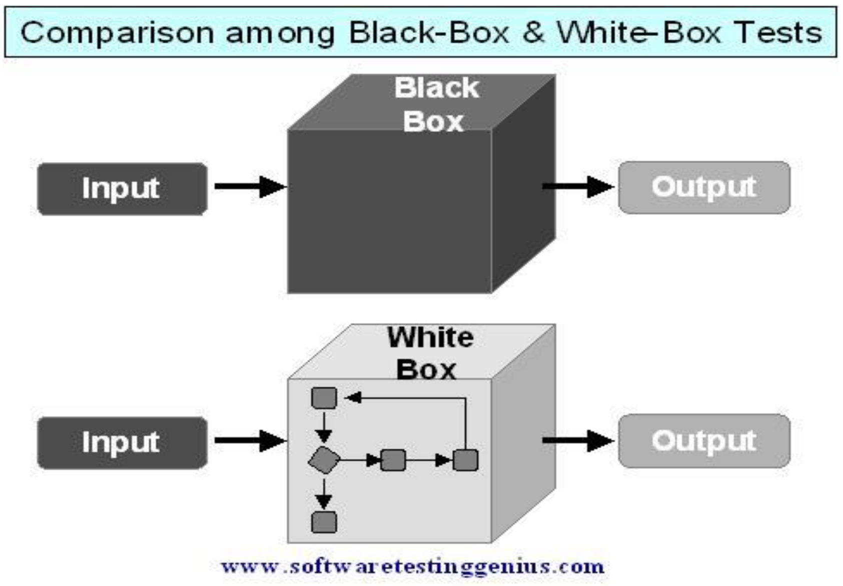
- Test script maintenance can be a burden if the implementation changes too frequently.
- Since this method of testing is closely tied to the application being tested, tools to cater to every kind of implementation/platform may not be readily available.

White Box Testing is contrasted with Black Box Testing.

<u>Q.Differences between Black Box Testing and White Box Testing</u>

The Differences between Black Box Testing and White Box Testing are listed below.

Criteria	**Black Box Testing**	**White Box Testing**
Definition	Black Box Testing is a software testing method in which the internal structure/ design/ implementation of the item being tested is NOT known to the tester	White Box Testing is a software testing method in which the interna structure/ design/ implementation o the item being tested is known to th tester.
Levels Applicable To	Mainly applicable to higher levels of testing: Acceptance Testing System Testing	Mainly applicable to lower levels of testing: Unit Testing Integration Testing
Responsibility	Generally, independent Software Testers	Generally, Software Developers
Programming Knowledge	Not Required	Required
Implementation Knowledge	Not Required	Required
Basis for Test Cases	Requirement Specifications	Detail Design


Comparison among Black-Box & White-Box Tests
Black Box
Input
Output
White Box
Input
Output
www.softwaretestinggenius.com

For a combination of the two testing methods, see Gray Box Testing.

Q.Explain gray box testing with its advantages and disadvantages.

3] Gray Box Testing

GRAY BOX TESTING is a software testing method which is a combination of Black Box Testing method and White Box Testing method. In Black Box Testing, the internal structure of the item being tested is unknown to the tester and in White Box Testing the internal structure is known. In Gray Box Testing, the internal structure is partially known. This involves having access to internal data structures and algorithms for purposes of designing the test cases, but testing at the user, or black-box level.

Gray Box Testing is named so because the software program, in the eyes of the tester is like a gray/semi-transparent box; inside which one can partially see.

Example

An example of Gray Box Testing would be when the codes for two units/modules are studied (White Box Testing method) for designing test cases and actual tests are conducted using the exposed interfaces (Black Box Testing method).

Levels Applicable To

Though Gray Box Testing method may be used in other levels of testing, it is primarily used in **Integration Testing.**