

(29)

**ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)**  
**ORGANISATION OF ISLAMIC COOPERATION (OIC)**  
**Department of Computer Science and Engineering (CSE)**

SEMESTER FINAL EXAMINATION

SUMMER SEMESTER, 2022-2023

DURATION: 3 HOURS

FULL MARKS: 150

**SWE 4805: Software Verification and Validation**

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all 6 (six) questions. Figures in the right margin indicate full marks of questions with corresponding COs and POs in parentheses.

1. The CSE department at IUT maintains a comprehensive record book to store Alumni student information. Within the department, two program types, namely CSE and SWE, each have their own set of required courses. Students are identified by unique IDs, grouped into batches, and enrolled in specific programs. Their academic history is documented in transcripts, detailing the courses taken along with corresponding grades. Grades can be A, B, C, D, and F. Courses can have some enrolled students and may require prerequisite courses for enrollment.

Apart from these, there are the following constraints:

- Each program has its own distinct set of required courses.
- A student can only be enrolled in one program, either CSE or SWE, but not both simultaneously.
- Students have completed the required courses as per their program's curriculum.
- Students from different programs have distinct academic histories, reflecting the courses they have taken and their corresponding grades.
- Students have completed the prerequisite courses for any course they have taken, as indicated by their academic transcripts.

You are hired to verify and validate the following statements:

- There are cases where students from different programs share the same batch while being enrolled in the same course.
  - The number of students in the record book is equal to the sum of the number of students in each batch.
  - There are some courses which are required in both programs.
  - Each student is enrolled in a course at most once.
  - A student has a grade higher than F in a course, then that course must be included in their transcript.
- a) Analyze the specification and constraints and write the signatures with their associated fields and facts. 5 + 10  
(CO1)  
(PO1)
- b) Write the given statements as assertions to verify and validate in Alloy. Justify whether a counterexample is found or not for each one. Assume that all the facts mentioned in Question 1.a) are incorporated. 5 × 2  
(CO2)  
(PO2)

2. You are developing a large-scale e-commerce platform that consists of multiple interconnected services, including user authentication, product catalog, payment processing, and order fulfillment.
- a) What types of mutations would you introduce in the integration tests, considering the specific characteristics of the e-commerce platform and its services? 5 (CO1) (PO1)
  - b) Explain how mutation testing can help identify weaknesses and vulnerabilities of the above e-commerce platform in the integration tests, such as inadequate error handling, incomplete data validation, and incorrect service interactions. 10 (CO2) (PO1)
  - c) How would you incorporate feedback from mutation testing results into the continuous integration and delivery pipeline to improve the overall quality of the e-commerce platform? 10 (CO2) (PO2)
3. You are tasked with testing a new e-commerce website that allows users to browse products, add them to their cart, and make purchases. The website has several key features, including user authentication, product search and filtering, product details pages, shopping cart functionality, and checkout process.
- a) How would you design test cases for black box testing of the product search and filtering feature? 5 (CO1) (PO1)
  - b) Discuss the challenges associated with white-box testing, including code coverage, path analysis, and maintaining test cases. 10 (CO2) (PO1)
  - c) Discuss the benefits of gray-box testing in uncovering defects that may be missed by either black-box or white-box testing alone. Provide examples of scenarios where gray-box testing would be advantageous. 10 (CO2) (PO1)
4. A software development company is working on a new autonomous vehicle control system. The system's software includes complex algorithms for navigation, collision avoidance, and decision-making.
- a) Why are traditional verification and validation approaches not applicable to autonomous vehicle systems? 5 (CO1) (PO1)
  - b) Discuss state-of-the-art verification and validation methodologies used in the automotive industry for the development of safety-critical components. 10 (CO2) (PO1)
  - c) Discuss strategies for designing effective regression test suites for the autonomous vehicle control system. How can automation tools assist in regression testing efforts? 10 (CO2) (PO1)
5. A financial institution is developing a new online banking system to provide customers with secure access to their accounts, transactions, and financial services. The system needs to undergo rigorous testing to ensure its reliability, security, and compliance with industry regulations.
- a) What is security testing and why is it essential for online banking systems? 5 (CO1) (PO1)
  - b) Discuss the advantages of model-based testing, including improved test coverage and early defect detection. How can model-based testing enhance the reliability of the online banking system? 10 (CO2) (PO1)



- c) Explain how security testing can be integrated into the software development lifecycle (SDLC) of the online banking system. What best practices should be followed to maintain security throughout the development process? 10 (CO2) (PO1)
  
- 6. You are developing a machine learning model to assist with the hiring process at a company. The model analyzes resumes and predicts whether a candidate should be invited for an interview based on various factors such as education, work experience, skills, and so on. However, after deploying the model, you discover that it disproportionately rejects candidates from certain demographic groups, raising concerns about bias and fairness in the hiring process.
  - a) What are the potential sources of bias in the hiring process that could manifest in the machine learning model? 5 (CO1) (PO1)
  - b) How can you identify and quantify bias in the predictions made by the model? What metrics and techniques would you use? 10 (CO2) (PO1)
  - c) How would you address concerns about fairness and bias in the model while ensuring that it maintains its predictive accuracy? 10 (CO2) (PO1)