

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



MID SEMESTER EXAMINATION  
 DURATION: 1 HOUR 30 MINUTES

SUMMER SEMESTER, 2022-2023  
 FULL MARKS: 75

### SWE 4805: Software Verification and Validation

Programmable calculators are not allowed. Do not write anything on the question paper.  
 Answer all 3 (three) questions. Figures in the right margin indicate full marks of questions with corresponding COs and POs in parentheses.

1. Consider the Alloy code shown in Code Snippet 1 and answer the subsequent questions.

```

1 sig ID {}
2 abstract sig Person {}
3 sig Faculty extends Person {}
4 abstract sig Student extends Person {
5     id: one ID,
6     transcript: set Course
7 }
8 sig Graduate, UnderGraduate extends Student {}
9 sig Instructor in Person {}
10 sig Course {
11     taughtBy: one Instructor,
12     enrolled: some Student,
13     waitlist: set Student,
14     prerequisites: set Course
15 }
  
```

**Code Snippet 1: An Alloy code for Question 1**

- a) Describe Code Snippet 1 in plain English.

5  
(CO1)  
(PO1)

- b) Explain the following facts in plain English.

5 × 2  
(CO1)  
(PO1)

- i. all i: Instructor | i in Faculty + Graduate
- ii. all c: Course | c.taughtBy not in c.enrolled + c.waitlist
- iii. all c: Course | some c.waitlist => some c.enrolled
- iv. all s: Student | s.transcript.prerequisites in s.transcript
- v. all s: Student | (waitlist.s + enrolled.s + s.transcript).prerequisites in s.transcript

- c) Assuming all the facts mentioned in Code Snippet 1 and Question 1.b are incorporated, analyze the following assertions independently and justify whether a counterexample is found or not.

5 × 2  
(CO2)  
(PO2)

- i. some Graduate & Instructor
- ii. all c: Course | c !in c.\*prerequisites
- iii. all c: Course | no (c.taughtBy & c.waitlist)
- iv. all c: Course | all s: c.enrolled | s not in c.waitlist
- v. one c: Course | some c.prerequisites and some c.enrolled

2. Consider the JavaScript function in Code Snippet 2.

```
1 function getPrimes(start, end) {  
2   let primes = [];  
3   for (let i = start; i<=end; i++) {  
4     let isPrime = true;  
5     for (let j = 2; j<i; j++) {  
6       if (i%j==0) {  
7         isPrime = false;  
8         break;  
9       }  
10    }  
11    if(isPrime) primes.push(i);  
12  }  
13  return primes;  
14 }
```

Code Snippet 2: A JavaScript code for Question 2

- a) How would you automatically generate test cases to verify Code Snippet 2? 5  
(CO1)  
(PO1)
- b) Create three types of mutants using Code Snippet 2 and a test suite of five test cases, and calculate the mutation score. 2 x 5  
(CO1)  
(PO1)
- c) Mutation testing takes a lot of time to execute if you have several test cases. How can we speed up mutation testing? Give your opinion and explain with examples that can be explored in the future. 10  
(CO1)  
(PO1)

3. The specification of a social network system (SNS) is given below:

SNS has three main entities: User, Email, and Post. A user has a unique identifier (id), a username, a set of emails and a set of friends, who are also users. Each email has an address and is associated with a provider, which can be either Google or Microsoft. A post includes an id, content, timestamp, and the user who authored it. Additionally, there is a set of likes, each having an id, timestamp, and the user who liked the post.

Apart from these, there are the following constraints:

- Every user must have a unique ID and a non-empty username and email.
- Friendship is symmetric; if User A is friends with User B, then User B is also friends with User A.
- Each post must belong to a single user's posts.
- Users can have multiple email addresses, but each email address must be unique.
- Friendship is transitive; if User A is friends with User B, and User B is friends with User C, then User A is friends with User C.

You are hired to verify and validate the following statements:

- Every user must have at least one post, and each post must have at least one like.
- There should be no friendship between users who haven't liked each other's posts.
- Users can not like their own posts

- Every user of the social network is somehow connected to each other.
- Users with email addresses from Google's service provider have a higher count of posts than those from Microsoft's service provider.

- a) Analyze the specification and constraints and write the signatures with their associated fields and facts. 5 + 10  
(CO1)  
(PO2)
- 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 3.a are incorporated. 5 × 2  
(CO2)  
(PO2)