INTERNATIONAL UNIVERSITY OF EAST AFRICA

'Learning to Succeed'

FACULTY OF SCIENCE AND TECHNOLOGY

END OF SEMESTER EXAMINATIONS - APRIL 2025

PROGRAMME: BSSE

YEAR/SEM: YEAR 3/SEMESTER 1

COURSE CODE: SWE3100

NAME: FORMAL METHODS OF SOFTWARE ENGINEERING

DATE: 2025-04-23

TIME: 9:00AM-12:00PM

INSTRUCTIONS TO CANDIDATES:

1. Read the instructions very carefully
2. The time allowed for this examination is STRICTLY three hours
3. Read each question carefully before you attempt and allocate your time equally between all the Sections
4. Write clearly and legibly. Illegible handwriting cannot be marked
5. Number the questions you have attempted
6. Use of appropriate workplace examples to illustrate your answers will earn you bonus marks
7. Any examination malpractice detected will lead to automatic disqualification.

DO NOT WRITE ANYTHING ON THE QUESTION PAPER

Section A Attempt All

Question 1:

1.Given the sets: A={1,2,3,4,5}, B={3,4,5,6,7} ,C={5,6,7,8,9} **(8 marks)**

Compute the following:

a) AuB
b) AnB
c) B-C
d) Power set of A

2.Given the set S={a,b,c,d,e}, find: **(4 marks)**

a) The cardinality of S, i.e., â?£Sâ?£
b) The number of subsets of S

3.Given the sets: X={1,2} and Y={a,b,c}, compute the Cartesian product XÃ?Y **(2 marks)**

4.Consider the relation R={(1,2),(2,3),(3,4)} on the set S={1,2,3,4} Determine: **(6 marks)**

a) The domain of R.
b) The range of R.
c) Is R a function? Justify your answer.

5) Why are formal methods necessary in software development? **(6 marks).**

6) What are some of the major challenges in applying formal methods in software engineering? (4 marks)

7.Translate each of the following statements into the language of sentential logic. Use the first letter of the capitalised word(s).

i. It is RAINING or OVERCAST, but in any case it is not SUNNY. **(2mark)**
ii. I will SUCCEED only if I WORK hard and take RISKS. **(2 marks)**
iii. It is not RAINING, but it is still too WET to play. **(2 marks)**
iv. If neither JAY nor KAY is home this weekend, we will go to the BEACH;otherwise,we will STAY home. **(2 marks)**
v.Either Jones is a FOOL or he is DISHONEST. **(2 marks)**

a.

Section B Attempt only three

Question 1:

Using examples of predicate calculus explain the following terms in formal specification **(20 marks)**

a) Predicates and Functions
b) Constants
c) Variables
d) Quantifiers

Connectives

Question 2:

a) What are formal methods in software engineering, and why are they important? (4 marks)
b) Explain the difference between formal specification, formal verification, and formal validation. (6 marks)
c) How do formal methods improve software reliability and security? (4 marks)
d) Discuss the challenges and limitations of using formal methods in real-world software development.(6 marks)

Question 3:

(a) Using truth tables, prove whether the following are tautologies, contradications or a contingent. Give reason for your answer.(10 marks)

i. $\sim (P \vee (P \wedge Q)) \vee P$.
ii. $((P \rightarrow Q) \rightarrow P) \rightarrow P$

(c) For each of the following, state whether its true or false giving reason for your answer.
A, B and C are sets.
i). If |A| = 3 and |B| = 4, then |AUB| = 7. **(**5 marks)
ii). if |A| = 3,|B| = |C | = 5,|A n B| = 2, |B n C | = 3 and |A n C | = |A n B n C | = 1,
then |A u B u C | = 8. (5 marks)

Question 4:

dscsd
a) Prove the following and explain your answer.
(10 marks)

$(A \rightarrow B) \leftrightarrow (\neg A \vee B)$

$(A \leftrightarrow B) \leftrightarrow ((A \rightarrow B) \wedge (B \rightarrow A))$

b) Explain the various proof rules that are often used with propositional calculus statements and write their symbolic representation. **(10 marks)**

Question 5:

a) Discuss the significance of correctness, consistency, and completeness in formal specifications and how do these attributes contribute to software reliability? **(10 marks)**
b) Describe the role of formal verification in software development and how does it differ from traditional testing methods? **(10 marks)**

Question 6:

a) Show

$$\nvdash [\forall x \in D\, R(x,x)] \vee [\forall x \in D\, \neg R(x,x)]$$

b) Show

$$\nvdash \forall x, y \in D\, [R(x,y) \vee x = y \vee R(y,x)]$$

Explain your answer both your answers.

c) Consider the following pairs of sentences. For each pair, determine if one implies the other, if they are equivalent, or neither. Explain your answers. **(9 marks)**

$\forall x\ \forall y\ P(x, y)$	$\forall y\ \forall x\ P(x, y)$
$\exists x\ \exists y\ P(x, y)$	$\exists y\ \exists x\ P(x, y)$
$\forall x\ \exists y\ P(x, y)$	$\forall y\ \exists x\ P(x, y)$