

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, 2021-2022****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 whereas
 corresponding CO and PO are written within parentheses.

1. a) What is Software Verification and Validation? Write 4 (four) differences with examples between Software Verification and Validation. 2 + 8
(CO1)
(PO1)
- b) What is formal verification? How can it be used to verify and validate the specification? 2 + 3
(CO1)
(PO1)
- c) Discuss the ten commandments of formal methods in engineering environments. 10
(CO1)
(PO1)

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

```

1 abstract sig Program {
2   required: some Course
3 }
4 one sig CSE, SWE extends Program {}
5 sig Course {
6   enrolled: some Student,
7   prerequisite: set Course
8 }
9 sig Student {
10  id: one ID,
11  batch: one Batch,
12  program: one Program,
13  transcript: set Course
14 }
15 sig RecordBook {
16   students: set Student
17 }
18 sig ID, Batch {}

```

Code Snippet 1: Alloy code of student's record book for Question 2.

- a) Describe the above code snippet in natural language. 5
(CO1)
(PO1)

- b) Explain the following facts in natural language. 5 x 2

- i. all s: Student | let p: s.program | (p in CSE => p not in SWE) and (p in SWE => p not in CSE) (CO2)
(PO1)
- ii. all s: Student, r: RecordBook | s in r.students => s.program.required in s.transcript (CO2)
(PO1)

iii. $\forall s_1, s_2: \text{Student} \mid s_1.\text{program} \neq s_2.\text{program} \Rightarrow s_1.\text{transcript} \neq s_2.\text{transcript}$

iv. $\forall s: \text{Student} \mid s.\text{transcript}.\text{prerequisite} \in s.\text{transcript}$
v. $\text{CSE.required} \neq \text{SWE.required}$

- c) Analyze the following assertions independently and justify whether a counterexample is found or not. Assume, all the facts mentioned in Question 2.b) are incorporated. 4×2
- i. $\forall s_1, s_2: \text{Student} \mid s_1.\text{id} \neq s_2.\text{id}$ (CO2)
 - ii. $\exists c: \text{course}, \exists s_1, s_2: c.\text{enrolled} \mid s_1.\text{batch} = s_2.\text{batch} \text{ and } s_1.\text{program} \neq s_2.\text{program}$ (PO2)
 - iii. $\exists c: \text{Course} \mid \#c.\text{enrolled.program} = 2$
 - iv. $\exists c: \text{Course} \mid c \in \text{CSE.required} \text{ and } c \in \text{SWE.required}$

- d) What does Alloy Analyzer do when we check an assertion? 2

(CO1)
(PO1)

3. Consider the following specification and answer the subsequent questions.

Assume a simple banking system where every bank has a unique number, name and a set of branches and different account-related activities (e.g. account creation, transaction) take place. In the same way, every branch has a distinctive name, number and a set of accounts. An account can be either an Individual or Business account with associated information, such as an account number, balance and account holder as the owner of that account. Every account holder has an identification number and name. To make the system more secure and auditable, each bank tracks all the transactions. Every transaction has a transaction ID, status (passed/failed), an amount, date, and the sender and receiver's account information.

- a) Analyze the specification and write the signatures with their associated fields and facts. 5

(CO1)
(PO1)

- b) Write the following constraints in Alloy as fact, considering the signatures and fields that you have designed in Question 3.a). 5×2

(CO2)
(PO1)

- i. No two account numbers and the transaction numbers are the same.
- ii. An account number can not be duplicated on multiple branches.
- iii. For a single successful transaction of an individual-and-business account, the account holder transfers maximum amount of 50,000 and 150,000, respectively.
- iv. An account holder has to transfer a minimum amount of 5,000 from individual account to business account and 3,000 for vice versa.
- v. After a successful transaction, the amount must be reflected to the respective accounts.

- c) Write the following statements as assertions to verify and validate in Alloy. Justify whether a counterexample is found or not for each one. Assume, all the facts, mentioned in Question 3.b), are incorporated. 5×2

(CO2)
(PO2)

- i. The amount of a transaction must be positive.
- ii. No two account holders have the same account number.
- iii. An account holder can not have more than 2 accounts in any particular bank.
- iv. All failed transactions transfer an amount which is greater than 5,000 from individual to business account.
- v. For every successful transaction, the balance of the sender must be sufficient and the sender's and the receiver's accounts must be valid.

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MID SEMESTER EXAMINATION
DURATION: 1 HOUR 30 MINUTES

SUMMER SEMESTER, 2021-2022
FULL MARKS: 75

SWE 4803: Software Project Management

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 whereas corresponding CO and PO are written within parentheses.

1. a)

Table 1: Data for Question 1. a)

Activity	Immediate Predecessor	Duration			10+10 +5 (CO2) (PO2)
		Optimistic	Most Likely	Pessimistic	
A		2 /	2	8 /	
B	A	4	5	12	
C	B	7	8	15	
D	A	10	14	18	
E	D	6	7	14	
F	C, D	7	9	17	
G	E, F	2	3	10	

Based on the data provided in Table 1, answer the following questions:

- i. Draw the Network Diagram using Critical Path Method (CPM) and identify the Critical Path
- ii. Draw the Network Diagram using Program Evaluation Review Technique (PERT) and identify the Critical Path.
- iii. Figure out the dissimilarities between CPM and PERT.

2. a) You are the project manager of a software project team consisting of 2 analysts, 4 software developers, and 3 test engineers. One new test engineer will join the team in two weeks. How many communication channels must be added due to the joining of the new engineer? 5 (CO2) (PO2)

b) Based on the data provided in Table 2, calculate the lowest cost of crashing to complete the project four weeks earlier than the baseline schedule. What activities should go through crashing for that? 5 (CO2) (PO2)

Table 2: Data for Question 2.b)

Activity	Baseline		Crash	
	Time	Cost (\$)	Time	Cost (\$)
A	10	4000	8	6000
B	2	6000	2	6000
C	14	22000	12	26000
D	6	9000	5	10000
E	9	14000	7	19000
F	8	18000	4	36000

c) You are working on a software project where each software module needs to be designed before the module can be developed. The technical design of module B (5 (CO2) 7

days) makes reference to the design of module A (10 days) and the design of module A needs to be completed 50% before the design of module B can be started. Also, the development of module A (15 days) depends on the development of module B (20 days), which needs to be completed 25% before the team can start the development of module A. (PO2)

Identify all the logical relationship from this given scenario and draw the project schedule network diagram mentioning the logical relationship.

According to the draft project schedule, coding work on an IT project spanned for 2.5 months with a 0.5-month free float. The number of developers required for the 1st, 2nd and 3rd month were 8, 2, and 5 respectively. According to the budget, the project can afford a maximum of 6 developers in any month. Alice, the project manager, requested Bob, the Development Lead, to adjust the resource requirements for the coding activities to align with the available budget. Bob rearranged the activities such that the developers required for the 1st, 2nd and 3rd month changed to 6, 4, and 5 respectively, and it resulted in extending the coding activity duration to 2.75 months. (CO2) (PO2)

Determine the resource optimization technique utilized by Bob. Also, mention the major differences between the resource optimization techniques.

3. a) The differences between managing people and leading people can be linked to a project manager's personality and ability to interact with individuals and groups. 5 (CO1) (PO11)
- Why does a project manager need to have both leadership and management skills in order to be the most effective?
- b) A project manager for a not-for-profit organization is completing a new software development project but is unable to get the planned amount of time from key resources to complete some of the critical path tasks. The key resources are focused on completing their day-to-day tasks, and the project manager does not control the work assignments for these people. 7 (CO1) (PO11)
- What type of organizational structure is the project manager in? What is the major limitation of your chosen organizational structure?
- c) The payback period can become an important issue when a large-scale project is developed over several years. You have been assigned the responsibility of calculating the payback period for your project that is to be completed in 3 years. The internal rate of return (IRR) is 7% and the annual savings will be \$800,000 per year. The total cost is \$4,000,000 and the rate of return during this time period is 3%. 5 (CO1) (PO1)
- What is the payback period of your project?
- d) You have four possible projects but can only choose one. Project A is being done over a six-year period and has a net present value (NPV) of \$70,000. Project B is being done over a three-year period and has an NPV of \$30,000. Project C is being done over a ten-year period and has an NPV of \$40,000. Project D is being done over a one-year period and has an NPV of negative \$160,000. 8 (CO1) (PO1)
- Which project should you choose? Justify your answer.

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Department of Computer Science and Engineering (CSE)MID SEMESTER EXAMINATION
DURATION: 1 HOUR 30 MINUTESSUMMER SEMESTER, 2021-2022
FULL MARKS: 50

CSE 4809: Algorithm Engineering

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 whereas corresponding CO and PO are written within parentheses.

- a) Each cell (i, j) in a sparse table stores the result of a particular function for the range $[j, j + 2^i]$ over an array, where i denotes the value of the row and j denotes the value of the column. Table 1 and 2 represent sparse tables for storing the maximum and minimum value over a range in the array A , respectively. The first row of both the tables is omitted. Recompute the original array A from these two partial sparse tables. 8
 (CO1)
 (PO1)

	1	2	3	4	5	6	7	
0								
1	10	11	11	9	9	15	15	-
2	11	11	11	15	15	-	-	-
3	-	-	-	-	-	-	-	-

Table 1: Sparse Table for storing Maximum Value

	1	2	3	4	5	6	7	
0	10	5	8	2	15	15	-	
1	5	5	8	8	2	2	15	-
2	5	5	2	2	2	-	-	-
3	-	-	-	-	-	-	-	-

Table 2: Sparse Table for storing Minimum Value

- b) Consider the following array: 12
 (CO1)
 (PO1)

$$A = [10, 5, 18, 14, 35, 32, 16, 4]$$

- i) Create a segment tree that can be used to find the GCD of any given range between 1 to 8 (maintaining 1-indexing notation) of A .
 ii) From the segment tree find out the GCD of the following range and make a list of the exact nodes of the tree that contributes to the GCD value:
- [1:3]
 - [3:4]
 - [4:7]

2. a) Create a Red Black tree by inserting the following sequence of numbers successively and show all the steps. 6
 (CO1)
 (PO1)

$$8, 18, 5, 15, 17$$

- b) If P is a node in a Red Black tree that has exactly one child, then argue on the following statements:
 i. The one child must be red.
 ii. The one child must be a leaf node.
 iii. The node P must be black.

3. Queen Artemisia of Persia, a renowned military strategist, was fond of arranging her soldiers in formations. Her army consisted of n_1 archers and n_2 cavaliers. Queen Artemisia believed that a formation was not aesthetically pleasing if there were strictly more than k_1 consecutive archers or if there were strictly more than k_2 consecutive cavaliers. You need to determine the number of visually pleasing formations of the soldiers. It is important to note that all $n_1 + n_2$ soldiers must be present in each formation. The archers are indistinguishable from one another, and the same goes for the cavaliers.

Propose an algorithmic solution to the problem.

(10)

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Department of Computer Science and Engineering (CSE)**MID SEMESTER EXAMINATION**
DURATION: 1 HOUR 30 MINUTES**SUMMER SEMESTER, 2021-2022****FULL MARKS: 75****CSE 4849: Human Computer Interaction****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 whereas corresponding CO and PO are written within parentheses.**

1. **a)** Bionic Reading (BR) is an application designed to aid its users to improve focus and increase speed while reading texts by highlighting pieces of words based on certain algorithms. Among the many settings available in the app, one modifies the portion of the words that is highlighted (let it be Stn_A), whereas another increases the amount of unhighlighted text between two consecutive highlights (let it be Stn_B). Examples are demonstrated in Table 1. 8
(CO2)
(PO2)

Table 1: Example of Bionic Reading for Question 1.a)

Type	Sample (part of a review taken from BR's website)
Raw	I learned about Bionic Reading through the Reeders news app. As soon as I toggled the bionic reading function, I was stunned by how quickly I could read. Jaw-dropping.
Default BR	I learned about Bionic Reading through the Reeders news app. As soon as I toggled the bionic reading function, I was stunned by how quickly I could read. Jaw-dropping.
Tweaked Stn_A	I learned about Bionic Reading through the Reeders news app. As soon as I toggled the bionic reading function, I was stunned by how quickly I could read. Jaw-dropping.
Tweaked Stn_{A+B}	I learned about Bionic Reading through the Reeders news app. As soon as I toggled the bionic reading function, I was stunned by how quickly I could read. Jaw-dropping.

Now, considering that the app does what it claims, based on your knowledge about human reading and the examples provided, speculate and explain with supporting arguments, how BR is helping its users to read texts easily.

- b) Suppose you are asked to digitize a fill in the blank task (with options) for an online English language test. In the task, an examinee will be presented with a paragraph of information where a certain number of words are left as blank. There will be a pool of words, with more words than necessary and the examinee needs to fill in the blanks with those words. While designing the digitized version, certain requirements need to be taken into account:

- A word from the pool cannot be used more than once
- User should be able to swap the words chosen between two blanks in case of a mistake
 - User should always be able to see an updated pool after changing the word in any blank
 - User should be able to clear a blank in the case of a mistake

Based on the aforementioned requirements, answer the following questions:

- i. Design an interaction method for the fill in the blank task to facilitate the aforementioned requirements and make it easy, effective and efficient for the examinee. Highlight in your answer how each of the requirements are being met. 8
(CO4)
(PO3)
- ii. Correlate how different higher-level design principles (visibility, feedback, constraint, mapping, consistency, and affordance) can be taken into account while proposing the design. 9
(CO2)
(PO2)

2. a) Given you are tasked with the design of a context menu for an application, you have come up with two different implementations, a vertical one and a radial one. Both the menus have 5 items in total. In case of the vertical menu, each item is rectangular in shape, with a height of 50px and width of 210px. In case of the radial menu, the items are circular with 60px diameter each and every item is located 100px away from the tip of the cursor. Drawings for the two menus are depicted in Figure 1.

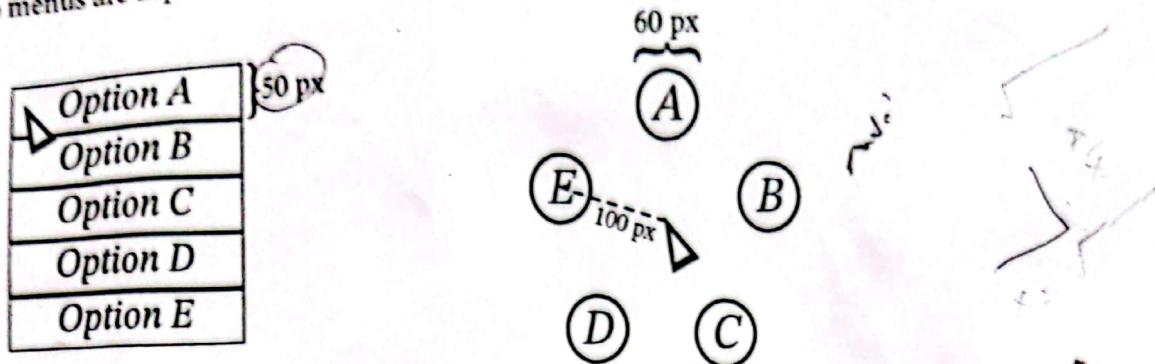


Figure 1: From left to right: vertical and radial menu samples respectively for Question 2.a)

Now, based on the aforementioned information, answer the following questions:

- i. Given you have a monitor of 146DPI (Dots Per Inch) and you are sitting 2 feet away from it, calculate the vertical visual angles (in degrees) for a single button in both the vertical and the radial menus. 6
 (CO1)
 (PO1)
- ii. With adequate mathematical reasoning, identify which of the aforementioned context menu would prove to be more difficult to operate on an average in terms of time taken to press a button. Consider that shortest path will be taken in each case. 8
 (CO2)
 (PO2)
- iii. Can the initial position of the cursor be changed in the case of the vertical menu to decrease the average difficulty? Justify with appropriate mathematical reasoning. 6
 (CO2)
 (PO2)

- b) Why are very large desktop monitors generally curved? Explain with appropriate reasoning. 5
 (CO2)
 (PO2)

3. In the context of unplanned cities, suppose you want to design a Virtual Reality (VR) Yoga Trainer app for the elderly people. Not only the elders can meet and greet each other and practice yoga with peers in a serene, calm, and aesthetic environment, but also there will be support from professional yoga instructors to correct the postures of the trainee and provide advice. The overall result might be achieved with the help of VR headsets, controllers and full body motion tracking cameras, which has recently been introduced to the commercially available home VR setups. Now based on the aforementioned information, answer the following questions:

- a) How can the interrelated aspects of HCI aid in the overall development process of the aforementioned app? Explain briefly with appropriate reasoning. 12
 (CO2)
 (PO2)
- b) "While designing such an app for the elders, proper ergonomics should be considered as a crucial factor" - Do you agree with this statement? Provide proper justification behind your decision. 7
 (CO2)
 (PO2)
- c) Write down three cases where you think use of haptics can make the overall experience of the given app more immersive and appealing. For each one, provide a brief explanation. 6
 (CO2)
 (PO2)

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MID SEMESTER EXAMINATION
DURATION: 1 HOUR 30 MINUTES

SUMMER SEMESTER, 2021-2022
FULL MARKS: 75

SWE 4801: Software Maintenance

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Answer all 3 (three) questions. Figures in the right margin indicate full marks of questions whereas corresponding CO and PO are written within parentheses.

1. A software company of Capability Maturity Model (CMM) level 4 has delivered "abc" software to "XYZ" company. Later on, "XYZ" company requested some feature extensions and bug fixes. The cost for proposed maintenance activities was a burden for "XYZ" company as they don't have enough resources now. So, the management team prioritized important features and bug fixes.
 - a) What do you understand by software maintenance? Why software maintenance is needed? 1+4
(CO1)
(PO1)
 - b) What is software evolution? Using Lehman's laws, explain what properties of evolution will affect the "abc" software through gradual maintenance works. 2+5
(CO2)
(PO2)
 - c) What model of software maintenance was adopted in the above mentioned scenario? If you replace this model with Osborne's model, what would have changed? Briefly explain. 2+6
(CO2)
(PO2)
 - d) According to the maintenance framework, briefly explain how the maintenance process will be conducted for the mentioned case in the scenario. 5
(CO1)
(PO1)
2. Redocumentation and design recovery are two forms of reverse engineering. Redocumentation is the representation of a program in a semantically equivalent form but at the same relative level of abstraction. Design recovery is the extraction of higher-level abstractions of the program.
 - a) Briefly explain how different level of abstractions could be achieved by "Redocumentation" and "Design Recovery". 8
(CO3)
(PO2)
 - b) Reverse Engineering simply enables an understanding of a system by representing it at an equivalent or higher abstraction level. To implement the understanding, you can take help of different supporting techniques. Briefly discuss the techniques. 8
(CO3)
(PO2)
 - c) Company "XYZ" is involved to manage an inventory system having more than 1700 data centers totaling over 1.4 billion lines of code. The main problem faced by the company are costly database operations due to the lack of standardized data and data structures. As a maintenance engineer what kind of solution you will provide to solve the mentioned problem. 9
(CO3)
(PO2)

3. a) Consider the ER diagram of the Departmental Shop Management System shown in Figure 1. A maintenance team want to edit this data model diagram by renaming the 'Item' module to the 'Product' module. From Figure 1 you can see that the 'Item' module is in relation to many other modules. So, if the 'Item' module is renamed, it will inevitably affect other modules. So, before making such changes, the team need to analyze well about the data model and the impact of the changes. In cases where the concerned people don't think carefully about the consequences of changes they are going to commit in the modules, it can affect the proper working of the application itself. This is why impact analysis is very important.

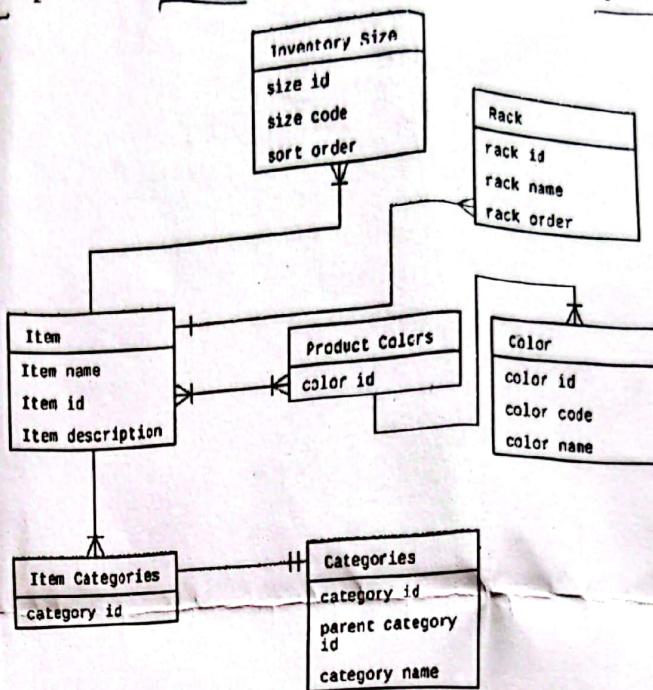


Figure 1: ER Diagram for Question no 3.a)

Answer the following question according to the scenario above.

- i. What is Impact Analysis?
- ii. How to conduct an Effective Impact Analysis?
- iii. How is Impact Analysis method useful to developers and testers?
- iv. How to prepare Impact Analysis document?
- v. What are some of the risks of not doing an impact analysis before effecting a change?
- b) List the different types of program understanding strategies and distinguish between them. Which of these strategies do you use and under what circumstances?

10
(CO3)
(PO2)

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MID SEMESTER EXAMINATION
DURATION: 1 HOUR 30 MINUTES

SUMMER SEMESTER, 2021-2022
FULL MARKS: 75

SWE 4833: UI/UX Design

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 Answer all 3 (three) questions. Figures in the right margin indicate full marks of questions whereas corresponding CO and PO are written within parentheses.

- ✓ 1. (a) How is universal design different from inclusive design? 5
(CO1)
(PO1)
- b) Headspace is a well-being and mindfulness app which has incorporated inclusive UI design practices. The font and the color of the texts within the app can be changed according to the user's preference. More importantly, Headspace integrates VUI (Voice User Interface), which is a speech-recognition interface to respond to human voice and turn voice into text. 10
(CO2)
(PO2)
- i. Ideate on how the app can be made more inclusive through further design changes.
 ii. How can typographic hierarchy be maintained despite allowing changes in the font and color of the texts on the app? 5
(CO1)
(PO1)
- ✓ 2. (a) How is font different from typeface? 5
(CO1)
(PO1)
- b) Iconography has become one of the most visually appealing elements of graphic design. Describe how the Gestalt's Principle of continuity is used in some digital and non-digital icon designs. 5
(CO1)
(PO1)
- c) When the Amazon team tested their interface in India, it turned out that people in India associated the magnifying glass icon (search icon) with a table-tennis bat or a ping-pong paddle and not with the 'Search' functionality. Suggest design changes in the interface that can solve this issue. 5
(CO2)
(PO2)
- i. Compare and contrast between a "usable" and an "equitable" product. 5
(CO2)
(PO2)
- ii. Brand X sells shoes for users with disabilities, and it wants to design an equitable e-commerce website to showcase its products. The CEO wishes the team to follow Lean UX, however the design team agrees that they should follow User Centered Design (UCD). Present an argument with appropriate reasons on why UCD may be more appropriate. 10
(CO2)
(PO2)

3. a) Imagine your company is building a new app for booking trips. The purpose of the app is to book trips for customers within a specified time window to a specified destination. You have an interview transcript with Mufti, a fourth-year student that lives in Dhaka with his family and loves to travel, given below. Based on it, create an empathy map for Mufti to identify the user needs for the app.

10
(CO2)
(PO2)

Interview Transcript:

"I am a student, but I work part-time remotely, so on my trips having good internet connection is crucial. My family doesn't like it when I am gone for long periods of time, so I take short trips on weekends. My remote work is often scheduled at night, leaving my day time free for trip activities. Sometimes, I book trips without comparing the prices when I am in a hurry, but when I am able to get the cheapest available deal, I feel accomplished. When booking trips online, I am concerned about my privacy and the protection of my credit card information. When I visit trip booking websites, too many similar options confuse me, lack of pictures of the hotel rooms frustrate me and if the page takes too long to load, then I leave the website. I'd love to find a booking platform where I could save my dream holiday packages even if I cannot afford them now. I'd love to be rewarded for going on trips frequently through offers or package deals. Ideally, I could schedule my trips days or weeks in advance if I get good service. I'm willing to pay a little more to get something like this instead of comparing multiple websites."

- b) What are personas? Suggest the different demographics of the personas required for the different types of users of the above app.

5
(CO1)
(PO1)

- i. Create a persona for the above app.

5
(CO1)
(PO1)

- c) Figure 1 shows the layout of "Hello Monday" creative studio's homepage. Discuss how white space has been used to create a striking layout.

5
(CO2)
(PO2)



Figure 1: Homepage for Question 3.c)