Question 1. Software Process (25%)

A company founded by a group of fresh CS graduates uses the following software development proces to develop their software products. You are one of the founders. You heard about the good things about agile processes and the need to handle technical debts with quality control through code review and the requirement engineering process should be rigorous.You would like to propose using them to develop the new project you receive. Nonetheless, the company has no prior experience in agile development.

[Scenario A] The current software process expressed by a project manager

Both my system analyst (SA) and I visit our client and meet with the client representatives to collect the software requirements through a series of meetings. The client elaborates the requirements and their purposes each meeting, and we listen. We ask questions to seek to confirm the requirements. Sometimes, they also provide us with sample inputs and outputs of their current systems for our reference. After each meeting, we prepare, update, and review a document named Document R to itemize the software requirements in textual forms. The outcome of the meeting series is to produce a finalized version of Document R, and the client signs off on this version (as a part of the contract and, as such, our company receives some money from the client). The user interfaces and how the user interfaces accept inputs and generate outputs are also in Document R.

I break down and re-group the requirements into subsystems and schedule my team to develop these subsystems one by one. I allocate the same amount of time to develop each subsystem to make the schedule predictable to the team and arrange the order of these subsystems into a schedule. I also append the schedule with the system integration and user acceptance test phases. The SA will refine my requirement allocations to subsystems and let me review and approve.

The programmers (Ps) study the requirements for each subsystem and discuss them with the SA in case of ambiguity. Sometimes, they also involve me in the discussion. If needed, the SA arranges additional meetings with the client representatives and discusses the details of the requirements listed in Document R for that subsystem. We will limit the number of such additional meetings to keep our company image professional.

We focus on delivering the requirements with the simplest possible design to gain speed and lower the development cost. Each subsystem is implemented by one P. The SA will set the priority of the tasks for the P to implement. The P also tests the subsystem manually while reading the requirements for the subsystem. The SA tests the subsystem implemented by the P. Of course, the SA also develops some code for the subsystem.

If there is any delay in the schedule for a subsystem, we work overtime on weekdays and weekends. We cut the schedule for the next subsystem if the delay of the current subsystem is serious to meet the original project milestones.

After producing all the subsystems, the SA and the Ps will integrate them into a whole system and test it. They test those scenarios related to what they have tested individual subsystems and brainstorm new scenarios to test the whole system. When developing individual subsystems or integrating the whole system, critical and major bugs are fixed if found. Integrating the whole system is challenging as many unexpected bugs usually pop up at this stage.

When we judge the system is ready, we fix all these minor bugs the clients may observe and arrange the clients to conduct a user acceptance test. Any bug found by the client and is within the scope of the contract is fixed by us. After passing the user acceptance test, we write the documentation as listed in the contract previously signed by the client. If the source code is also required to be handed over to the client, we will delete all these debugging statements from the source code and pass the resulting code base to the client. Deferring the documentation and minor bug fixing to the final stage helps my team reduce the overheads in code and document revisions. Finally, we pass the system to the client.

Your goal is to explain how an agile process differs from the current process (i.e., Scenario A)2current process (e.g., a concrete example or description of the current process). (5 points for each)to your company partners. Your explanation should be supported by the information of the current process(e.g., a concrete example or description of the current progess).

(a) The organization of the development phases in the software ddvcbpment lifecycle

(b) The involvement of customers

(c) Prioritization of tasks to perform

(d) The duration period of a subsystem

(e) Programmers' control on the tasks they perform

Question 2. Software Requirements (25%)

(a) Give one example of a measurable non-functional requirement and describe what changesto your example so that it becomes non-measurable. Explain your change. You **are notallowed to take any examples from the materials of this course. (5 points)**

Example of measurable non-functional requirement
Change made and explanation

(b) Requirement elicitation has five basic types of activities How do you use them to improvethe requirement elicitation activities described in the current software processes in Question1? Your answer should be **explicitly and directly relevant** to the information described inScenario A. **(20 points, one area of improvement carries 4 points)**

- General/generic answers or vague answers may receive zero marks.

Question 3.Software Architecture(25%)

LeaveHomeSafe (Chinese: 安心出行) is a digital contact tracing mobile application provided by the Hong Kong Government during the COVID time. It has a few functionalities:

- scan a QR code and press a button to indicate that the user has entered a shop
- press a button to indicate the user leaves the shop
- automatically leave a shop after a certain time (e.g., an hour)
- receive a notification over the internet and notify whether the shop entered in the past N days incurs any COVID-19 threat.

There was a comment that the app should be enhanced to ease the visually impaired persons(e.g., a person with a decreased ability to see) to use the app. For instance, such a person may be unable to locate and scan a QR code with ease.

The following is a list of requirements:

(a) . Each shop should be assigned with a unique beep sequence.

(b). Each shop should install a single speaker to emit its beep sequence repeatedly when the speaker turns on.

(c) . A beep can be either short or long like the morse code (Traditional Chinese: 摩斯電碼; Simplified Chinese: 摩尔斯电码). The length of the beep sequence for a shop should not be longer than 32 beeps, and the sound emitted by the speaker should be higher than withinin the range suitable for the population of visually impaired persons.

An AI chatbot provides the following information:

> Some studies suggest that blind individuals may be better at distinguishing between similar frequencies or pitches, particularly in the higher frequency range (above 2,000 Hz), which can be critical for understanding speech and environmental sounds.
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> ---
>
> When designing a beep sequence that is more likely to be perceived by blind individuals without being overly disruptive to sighted individuals, consider the following guidelines:
>
> 1. Frequency Range:
> - Use frequencies in the range of 1,000 Hz to 4,000 Hz. This range is often more easily detectable and can be less intrusive for sighted individuals.
>
> 2. Pitch Variation:
> - Incorporate slight variations in pitch or frequency between beeps to enhance auditory discrimination without being jarring. For example, using frequencies that differ by 100 Hz can help maintain sensitivity for blind individuals.
>
> 3. Duration and Rhythm:
> - Beeps should have a clear rhythm and duration. Short, distinct beeps (e.g., 200-300 milliseconds) with pauses in between can aid in detection.
>
> 4. Volume Level:
> - Ensure the volume is at a moderate level that is audible but not overwhelming. This helps to make it detectable without being disruptive.

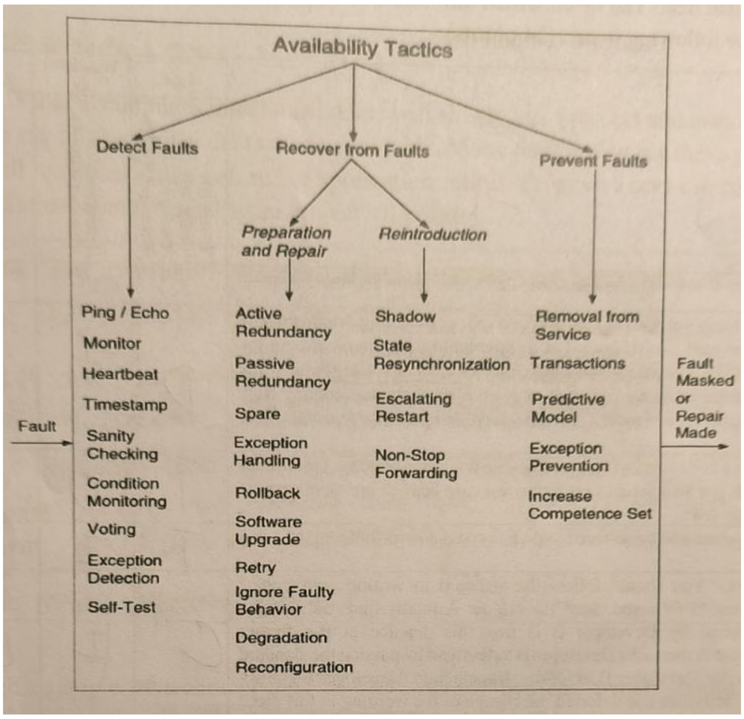
5. Harmonic Tones:

- Consider using harmonic or melodic sequences rather than pure tones, as they can be more pleasant and easier to discern.

(d). The app can hear a beep sequence from a speaker with an accuracy of 95% or higher from the microphone of a low-end mobile phone.
(e). The app can use the beeps heard to identify a shop with an accuracy of 95% or higher.
(f) . Within 3 seconds after the app speaks out the shop name, if a user uses a figure to knock on the phone display three times within 1.5 seconds, the app will mark the user to enter the shop.
(g). The app will cache the mapping between the beep sequence heard in item (e) and the marked shop in item (f) for one month to speed up the next round of processing of the shop.

(a) Extract **four** quality attributes of the app from the requirement and paraphrase them into your own words. For each quality attribute, you should also state the suitability of Model, View, and Controller (MVC) architecture. **(20 points)**

- Note that direct copying will receive no mark.



(b) The target user population are visually impaired persons. The person is difficult to know ifthe enhanced app is not responding or crashed. Sketch a design plan to design the app to addressthis issue. **(5 points)**

Question 4. Technical Debt (25%)

(a) Technical debts can be classified into four dimensions. Determine the four dimensions ofeach ofthe following items. **(14 points)**

	Type	Intentionality	Time Horizon	Degree of focus
	DCTO	IU	SL	FU
e.g., Let's use the latest programming languages, tools, and frameworks to implement individual features in our project	C	I	L	U
Blockchain is not ready yet. Our application does not need to support blockchain as a platform in the next two releases. Let us now build our system without the need to prepare it to be a decentralized application. Nonetheless, we should thinkabout the consequence when we code our program if blockchain is coming backand we need to support it and record our consideration into a file folder for later reference.				
Make a change on a code file and forget to update the corresponding unit testingtest cases. As such, we also forget to pass the test case code to our development buddies for code review.				
Add hard-coded values and brute-force logic to bypass a hard-to-debug bug in a code region.				
Developer A says, "You should follow the standard in writing your code." Developer B replies, "I followed. See?" Developer A finally finds out that the "standard" mentioned by Developer B is from his practice in B's former company. Developer A then asks Developer B to fix them by passing the standard of "our" company for Developer B to follow. Nonetheless, Developer B is busy with other coding activities and deferred the change of the wording in this piece of code to the next development cycle (sprint in Scrum for example).				
We are running out of time, so everyone should be a programmer this week. Josh stop proofreading the documentation and help write the code with Mary.				
In a review meeting on a piece of code, a developer says, "What is the purpose ofthis value here?" Another developer replies, "Who knows? It was there for years!The system works fine." After tracking the history, there were attempts to removethis value from the code, but it always breaks the code if removed. There was noidea on how to fix this issue.				
Mary is competent. She is asked to improve the error handling of an application component. Mary is confident in completing the task in a week. However, as she digs into the code, she finds many inconsistencies in logic, bad dependencies, and other code issues. So, Mary decides to clean up all these issues before working on improving the error-handling part of the component. As she makes necessary changes, she further notices that there is no unit test case. She continues to make major changes to the code despite lacking unit test cases to assist her and finally commits the code to the main code repository. Everything looks alright. Nonetheless, she does not realize some deeply hidden dependency issues in some configuration files. The logic tied to some ad hoc values in some other code				

sections to bypass some previous bugs is now broken by her changes, making the application fail. Finally, she gets everything working, but the originally estimated one-week effort now becomes three weeks. Also, after she publishes (pushes) her changes, other developers sometimes can and sometimes cannot test the application due to the broken dependency. All developers are now puzzled. They do not know how to fix the broken problem while supporting the delivery and maintenance of the application.				

(b) A saying is that accumulating technical debts will slowly kill a project and even a company.Many people say that technical debts are unavoidable. Many people also say that a project does not resolve all technical debts before the application retires. Propose a cost-effective strategy to handle technical debts in a software project. **(8 points)**

(c) Give one example of technical debt in your course project, which should belong toDocumentation, Intentionally, Short Term, and Unfocused. **(3 points)**