FACULTY OF SCIENCE
ACADEMY OF COMPUTER SCIENCE AND SOFTWARE ENGINEERING

MODULE	**IFM03B3 & IFM3B10** INFORMATICS 3B: ADVANCED SOFTWARE ENGINEERING
CAMPUS	APK
FINAL SUMMATIVE ASSESSMENT	NOVEMBER 2020

DATE		2020-11-09	**DOWNLOAD ALLOWANCE**	08:30–08:40
			WRITING TIME	08:40–11:40
			UPLOAD ALLOWANCE	11:40–12:40
ASSESSORS			PROF W.S. LEUNG DR F.F. BLAUW	
EXTERNAL MODERATOR			PROF A. VAN DER MERWE *(UNIVERSITY OF PRETORIA)*	
DURATION	*DOWNLOAD TIME*	*10 minutes*	**MARKS**	150
	WRITING	*3 Hours*		
	UPLOAD TIME	*1 Hour*		

MEMO

QUESTION 1: QUALITY CONCEPTS [15]

1.1. Effectiveness (3)
1.2. Efficiency (3)
1.3. Satisfaction (3)
1.4. Freedom from risk (3)
1.5. Context coverage (3)

Marking Notes:

- For the above, students must describe what would constitute as a indication of the five characteristics with regard to the "sign-up" (users do not provide their registration details) process.
- 3 marks are given for each quality characteristic.
- For reference:
  - **Effectiveness:** accuracy and completeness with which users achieve goals
  - **Efficiency:** resources expended to achieve user goals completely with desired accuracy
  - **Satisfaction:** Usefulness, trust, pleasure, comfort
  - **Freedom of risk:** Mitigation of economic, health, safety, and environmental risks
  - **Context coverage:** Completeness, flexibility

0	Provides the wrong interpretation of the characteristic (e.g. Effectiveness is described as being comfortable)
1	Correct interpretation, but really just a definition, no actual application.
2	Correct interpretation, with application, but is either a shallow reference or only relates to a limited portion of the characteristic (e.g. satisfaction: users find the experience of installing the app with ease)
3	Correct interpretation, comprehensive application (e.g. context coverage: users are able to install the app, indicate their consent, and have the option of granting permissions according to several options)

Question 2: Conducting Technical Reviews [10]

2.1. What is the error density of the Contact Exchange Design that was agreed upon at the technical review? Show your full calculations. (2)

Marking Notes:

- Error density is calculated as follows:

$$\text{Error density} = \text{Err}_{tot} / \text{WPS}$$
$$\text{Error density} = 3 / 14 = 0.2142$$

- Student MAY round up

0	• Incorrect formula • Just the final answer, no actual calculation
1	• Used the correct formula, but incorrect figures • Correct formula, correct figures, but performs calculation error
2	• Correct formula, correct figures, correct calculation

2.2. Discuss the above technical review. Your commentary should cover: (8)

a) Its conformance to technical review guidelines.
b) The performance of the team on the design work product, in comparison to previous projects.
c) Nosipho's prepared review.

Marking Notes:

- Marks awarded for the following discussion points (overall cap at 8) – other reasonable discussions may also be accepted:

0–7	• Conformance to technical review guidelines:
	  • Scope of work being reviewed is a work product (detailed component design of Contact Exchange) which is good – 1
	  • Preparation did not take more than 2 hours (good) – 1
	  • 7 people were involved in the review when it should have been between 3 and 5 (bad) – 1
	  • Duration of actual review was 30 minutes (less than 2 hours, therefore good) – 1
	  • Review Summary report is short (good) – 1
	  • Review Summary would not serve as a very good action item checklist (bad) – 1

0–3	• The team has performed better than in the past (0.2142 vs 2.06 per UML diagram) – 1 • The team MAY have improved their design work drastically – 1 • The review might not have been effective in finding all the errors – 1
0–3	• Nosipho's original reporting would have led to an error density of 1.9286 – 1 • This would have been closer to the average error density – 1 • The possibility exists that Nosipho's identification of errors was not incorrect – 1

Question 3: Software Quality Assurance [15]

3.1. Identify and describe two different processes and their "outputs" in `COVIDify` that you would measure to determine current quality performance (and to collect defect metrics) in relation to the above wrongful notification issue. (6)

3.2. Choosing one of the two different processes that likely is the cause of the error, describe how you would analyse the defect metrics to determine the cause(s). (3)

3.3. Propose how you would improve the process to eliminate the root cause of the defect. (3)

3.4. Describe how you would ensure that future work does not reintroduce the cause(s) of the defect. (3)

Marking Notes:

- This question tests the student on their application of Six-Sigma. Each question is essentially a guided step in the Six-Sigma process with the intention of nudging the student towards detailing their strategy for addressing a fault in the existing COVIDify app.

3.1	• Three marks given for each of the two different processes and their outputs
	• Limit to 1 mark (each) should the process provided not convince the marker that it would link to the issue of everyone being notified
	• Potential processes of concern could be:
	  • The storing of people the app user has been in contact with: a list of the other users is stored on the phone
	  • The app incorrectly captures a "COVID-19 positive" status for users: notification sent out to all other users on the contact list maintained by the app

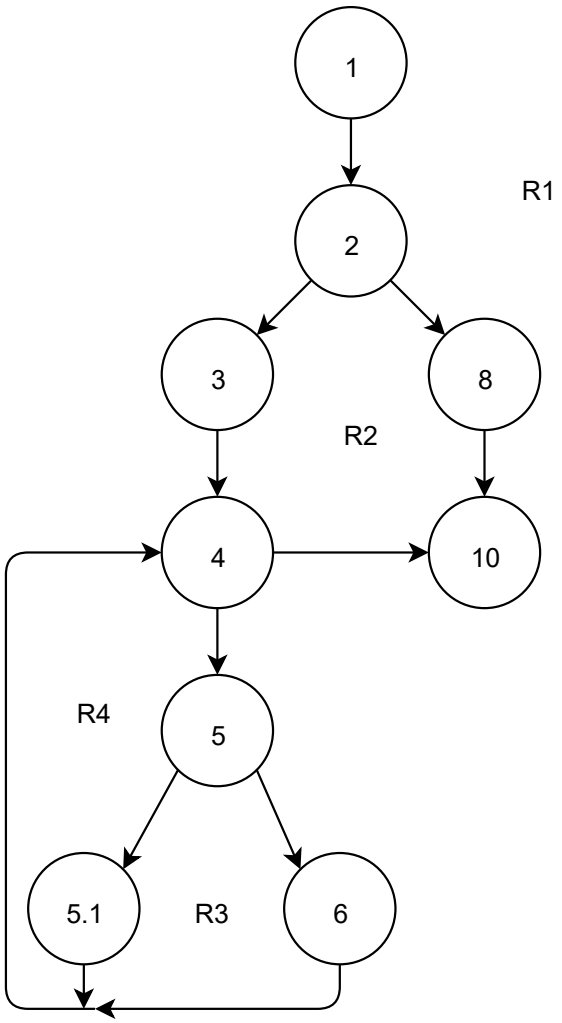
3.2	• Depends on student's answer but should describe the analysis based on ONE of the processes identified in the previous question.
3.3	• Depends on student's answer but should describe an improvement to the process (to address the issue).
3.4	• Depends on student's answer. The more generic answer should describe how one tests future integrations regressively.

QUESTION 4: SOFTWARE TESTING [40]

4.1. Using basis path testing, demonstrate how Donald may derive adequate test cases for conducting white-box testing of the above unit. Your answer *(which should show your FULL working out)* should conclude by defining the set of independent paths. *Note that marks will ONLY be awarded for ONE method of establishing the number of independent paths.* (10)

Marking Notes:

- Student should start by identifying the number of independent paths. This may be achieved either by (4 marks awarded):
  - Identifying the number of predicate nodes (2, 4, 5), ∴ V(G) = 3 + 1 = 4
  - Drawing the following flow graph, which leads to two options (their numbering of the nodes may be different):



  - V(G) = Edges − Nodes + 2 = 11 − 9 + 2 = 4
  - V(G) = number of regions = 4
- Student should then list the four independent paths (6 marks awarded):
  - 1-2-3-4-5-5.1-6.1-4-10 (2)
  - 1-2-3-4-5-6-6.1-4-10 (2)
  - 1-2-8-10 (1)
  - 1-2-3-4-10 (1)

4.2. Describe how black-box testing will complement the white-box testing done on the above unit by briefly discussing the three relevant black-box testing techniques that have been discussed. (10)

Marking Notes:
- Student to discuss in relation to the Contact Notification unit provided (3/4 marks each, capped at 10):
  - Interface testing:
    - Use of stubs and drivers to test that the component will accept information passed to it and return information in correct format
    - In this case, testing whether it is able to check user input for whether the person tested positive for COVID-19, as well as the list of contacts in the list
    - Output should be notification messages
  - Equivalence testing:
    - Division of classes of data to test all possible cases
    - This should include testing not positive, with a list of contacts; positive, with a list of contacts; not positive, no contacts; positive, no contacts; varying number of contacts (no contacts, 1 contact, many many contacts)
  - Boundary Value Analysis
    - This is to test boundary values
    - In this case, list should contain people who are on 14 days contact, less than 14 days, more than 14 days

4.3. Donald is opting for a depth-first, top-down integration approach for `COVIDify`. With specific reference to `COVIDify`, explain to Joe what this entails and why this is suitable for the current circumstances. (7)

Marking Notes:
- All components on a major control path is tested
- Begin with the main control module (which is the front interface itself) from which all functionality is accessed.
- From here, one subordate stub is replaced with an actual component, with each stub linked to it substituted.
- So in the case of the Contact Notification, the unit and all its associated stubs will be replaced and integrated before moving back to the main control module to explore the next subordinate stub
- This will allow Donald to show functional capability early on, which is seen to be a confidence builder. Given that Joe does not seem to have much faith in Donald, this show might assist in restoring some of that confidence.

4.4. Joe has indicated that the South African government wishes for `COVIDify` to be made available in all official languages. It is currently available in...English *(which needs editing)*. Discuss a resource-effective option that may achieve this. (5)

Marking Notes:
- Discussion of crowdsourcing to engage localization.
- Required to find community that has a track record of succeeding.
- Could therefore engage with South Africa community and ask them to provide the translations.
- The concern is the protection of intellectual property but in this case, part of the source code comes from Google/Apple so likely not a concern.

4.5. At present, only an Android native app is available for deployment, with an Apple version planned once the Android one is released to the public. Would developing a hybrid app have been a better choice? (8)

Construct a Weighted Device Platform Matrix (WDPM), basing this on how 97% of all South Africans have a smart phone and that Android and Apple represent 82% and 13% of the market share respectively, to justify your answer. *Simply constructing the WDPM is not enough - provide an interpretation of what this means before answering the above question.*

Marking Notes:

- 5 marks for the WDPM, 1 mark for the itnerpretation, 2 marks for answering the hybrid or native app question
- A WDPM must be constructed by following these steps:
  - List the important operating system variants as the matrix column labels
  - List the targeted devices as matrix row labels
  - Assign rankings (0 to 10) to indicate the relavtive importance of each row and column
  - Multiple the product of each pair of rankings, using NA where combination is not available
- The above matrix should show that the majority of users are on Android and therefore, testing an Apple version of the system is probably not ideal
- A hybrid app is therefore probably a better choice.

Question 5: Software Metrics and Analytics [5]

5.1. What is the customisation index for `COVIDify`? (2)

Marking Notes:
- Customization index C = N_{dp} / (N_{dp} + N_{sp}) = 5 / 64 = 0.078
- Student MAY round up

0	• Incorrect formula • Just the final answer, no actual calculation
1	• Used the correct formula, but incorrect figures • Correct formula, correct figures, but performs calculation error
2	• Correct formula, correct figures, correct calculation

5.2. Describe how typing effort could be measured as an interface metric on the `COVIDify` app. (3)

Marking Notes:
- Answer should revolve around collecting the average number of keystrokes required for each of the functions

Question 6: Project Management and Creating Viable Software Plans [10]

6.1. A count of the lines of code behind `COVIDify` reveals that there is an estimated 5700 lines of code. By considering HealthSurance's experience on similar projects, the organisation's average productivity is about 560 lines of code per month. The burdened labour rate is estimated to be R65 000 a month. Calculate (show your full working out): (6)

- The estimated person months *(round off to nearest person-month)*.
- The cost per line of code *(round off to nearest whole number)*.
- The estimated project cost *(round off to nearest 1000)*.

Marking Notes:

- Two marks per calculation (see rubric for calculations below):

0	• Incorrect formula • Just the final answer, no actual calculation
1	• Used the correct formula, but incorrect figures • Correct formula, correct figures, but performs calculation error
2	• Correct formula, correct figures, correct calculation

- Estimated Person Months: 5700 / 560 = 10.17 months (round off to nearest whole number is 10 months) – *but will accept 11 as it is person months and some students interpret as whole part*
- Cost of line per code: 65 000 / 560 = R116.07 per LoC (round off to nearhest whole number so 116)
- Estimated Project Cost: 5700 × 116 = R661 200 (round off to 661 000)

6.2. With less than one week remaining before `COVIDify` must be released, is it advised that Donald requests additional developers to join the `COVIDify` project to get things done? Motivate your answer. Provide brief guidelines on what Donald should do. (4)

Marking Notes:

- More hands on deck does not equate to getting things done quicker
- Additional developers must be brought up to speed (is there time to do this? Probably not)
- If it MUST happen, however, have these newcomers work on modular, unassociated components
- In this way, the amount of required communication (teaching) is reduced
- Marks are awarded based on the rationale and reasonable motivation provided by the student.

Question 7: Risk Management [20]

7.1. Identify and briefly describe two potential risks relating to `COVIDify` that are relevant to two different categories of risk. (6)

7.2. For each risk identified in 7.1, assign a risk probability (as a percentage), and describe the perceived risk impact *(in rand value)* to calculate a risk exposure for each. Provide motivations for each of the values you assign. (6)

7.3. Choosing one of the risks you have identified, describe the mitigation, monitoring and management plan for that risk. (8)

Marking Notes:

- Mark according to student input

7.1:

- Potential risks should be relevant to COVIDify
- Risk categories available (they must choose two):
  - Product size
  - Business impact
  - Stakeholder characteristics
  - Process definition
  - Development environment
  - Technology to be built
  - Staff size and experience

7.2:

- Student to allocate values as appropriate (appropriateness will be determined by the student's motivation

7.3:

- Mitigation, Monitoring, and Management should be realistic and logical

QUESTION 8: ABOUT A POPI(A) [20]

8.1. From a legal perspective, is Joe correct that Donald's choice of Microsoft Azure region is costing the South African public purse more than is necessary? Motivate by discussing the legal rationale for choosing Microsoft Azure services hosted in the South African region, as opposed to one in the United States of America. (8)

Marking Notes:
- Privacy laws in the United States are generally considered to be less strict than that of South Africa
- (States have varying privacy laws)
- To safely comply with POPIA, it is best to ensure that the physical location of where data (personal) being stored or processed is located in a country that complies with the POPIA requirements (i.e. choosing South Africa)
- Otherwise, there may be no recourse against any issues arising later
- The Information Regulator can impose hefty fines (and include jail time) for those responsible. This should be good enough reason not to try save on money
- POPIA is anticipated to be fully enforceable by July 2021.

8.2. What compromise would you suggest in response to the deadlock above? Motivate your answer. (4)

Marking Notes:
- Choose another country where hosting may be cheaper, but still have just as strict laws
- An easy option is an EU country. However, EU's GDPR rules (stricter than POPIA) leads to higher hosting costs.
- The UK has lower costs (and are subject to GDPR rules)

8.3. Comment on the legality of Donald's Artificial Intelligence-inspired initiative. What must be done to address the concerns adequately (in a legal manner)? (8)

Marking Notes:
- Not legal
- Participants whose information is stored must be informed of the purpose of this AI initiative
- Participants whose information is already stored must be able to withdraw this information (access to certain rights)
- Participants must be kept informed of the state of their information at all times
- Participants should be informed during sign up that it will be used for further information
- If this information used by the AI is not necessary for the original purpose, it can not be collected in the first place.

Question 9: A Strategy for Software Support [15]

9.1. The Minister's request would effectively require you and your company to take on the maintenance duties of `COVIDify`. Compare the approaches of reverse engineering and refactoring (6). Explain which of the two approaches would appear better-suited should you need to take over from HealthSurance (2). (8)

Marking Notes:

- Reverse engineering is generally used when systems being maintained are of low quality and in high technical debt
- Reverse engineering allows one of extract the design information from the source code instead
- Mileage of this outcome may vary

- Refactoring modifies the source code/data to make it amenable to future changes
- Overall program architecture is generally not modified
- Typically for when basic architecture is solid (just technical internals require work)

- Student may choose either one, as long as it is backed by a valid motivation (if their view is that the design has been terrible this whole time, go with reverse engineering).

9.2. Another aspect to consider is whether the costs involved will still be beneficial to your client *(The Department of 4IRHealth)*. Use the following information to motivate your answer, showing your FULL working out: (7)

- Current `COVIDify`:
  - Current maintenance costs for `COVIDify` is anticipated to be R300 000 a year.
    - The annual operating cost of `COVIDify` is a fixed R302 400.
    - The business value linked to running `COVIDify` is difficult to quantify for obvious reasons. For the purpose of the exercise, use 1 million rand.
- Re-engineered `COVIDify`:
  - Maintenance costs will be halved.
  - Annual operating costs do not change.
  - Predictions suggest that there will be a 25% increase to the existing business value after re-engineering efforts.
  - Your company charges R275 000 for a project of `COVIDify`'s size.
  - It will take your company 2 months to re-engineer `COVIDify`.
  - The risk factor for re-engineering `COVIDify` is 1.0 *(your current involvement ensures nominal risk)*.
- It is anticipated that `COVIDify` will continue to be of use for another 1.5 years.

Marking Notes:

- C_{maint} = [Current annual business value - (Current annual maintenance + Current annual operations cost)] × Expected life of the system
- C_{maint} = [1 000 000 - (300 000 + 302 400)] × 1.5 = 596 400

- C_{reeng} = predicted annual business value - (predicted annual maintenance + predicted annual operations cost) × (Expected life of the system - Estimated reengineering time) - (estimated engineering costs × reengineering risk factor)
- C_{reeng} = 1 250 000 - (150 000 + 133 900) × (1.5 - 0.1666) - (275 000 × 1) = 596 466.67

- Cost benefit = C_{reeng} - C_{maint} = 596 466.67 - 596 400 = 66.67
- Therefore, the cost benefit is positive.

Students at this point may argue that it is positive, therefore, worth it. (they can get all the marks) BUT Students who argue that the positive amount is actually very negligible should be marked as correct too.

2 marks for each calculation
1 mark for final argument