The School of Computer Science and Information Systems
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CS777: Software Reliability and Quality Assurance

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Final Exam

May 13, 2008
3 hours

Students MUST answer section 1
Then answer ANY 2 sections out of sections 2, 3 and 4

Use the allocated marks per section to judge the expectation for your response

Managing your time is your responsibility, so DO NOT repeat the question in your answer

Write on the exam booklet for section 2 and use the separate booklet for sections 1, 3 and 4

This exam is closed book and no electronic devices may be used

YOUR NAME:

DO NOT START - UNTIL INSTRUCTED TO DO SO

1. General Questions *[20 points]*

(5 points per question)

1.1 Describe the **relationship between** software reliability and software quality. Are they one and the same? Are they different? Can software be of quality yet be unreliable? Substantiate your answer.

1.2 It is often claimed that hardware and software fail in different ways. Explain this claim and its **implications** for being able to estimate and predict reliability. Do you agree with this claim? Substantiate your answer.

1.3 What are the major areas of uncertainty that make accurate software reliability predictions problematic to obtain? Summarize each area.

1.4 Compare and contrast 2 software reliability growth models of your choosing to explain how they may account for the above areas of uncertainty differently. Can you realistically say that one of these models is 'better' than the other? Explain your answer.

~~END OF SECTION 1~~

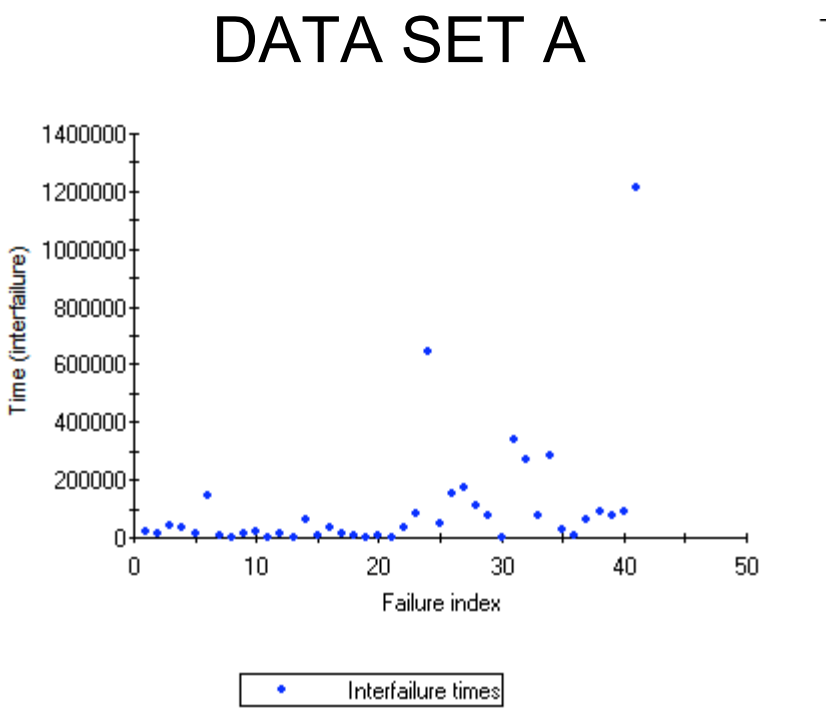
2. Software Reliability Growth Models *[40 points]*

(Points will be allocated evenly between the questions or portions thereof – so be careful to answer ALL parts of ALL questions to gain full marks. This question is a great one to pick up lots of marks if you attempt all pieces.)

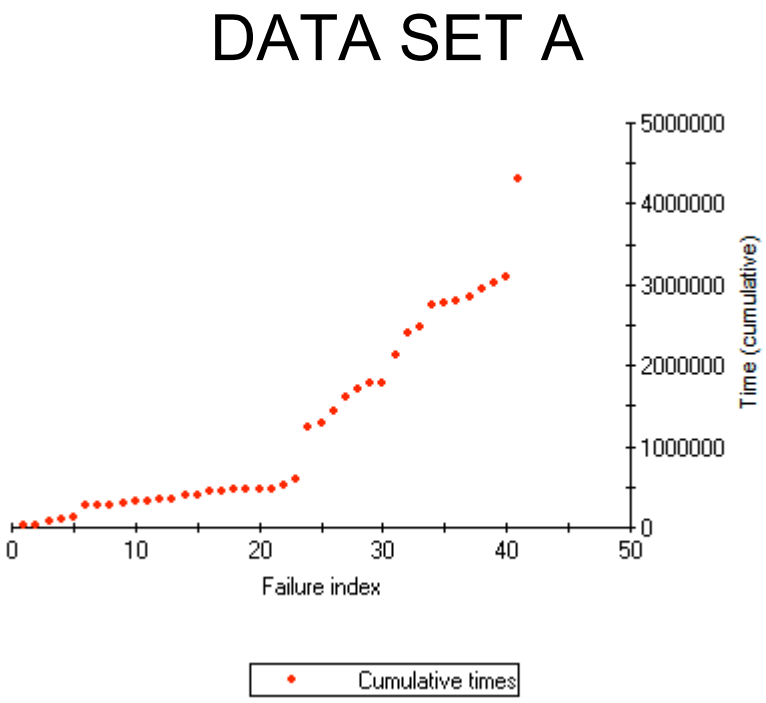
In this section, you are provided with a number of graphical plots of failure data and asked to answer a series of questions about them. The data that is being used here is inter-failure time data (i.e., time between failures) and the time unit is seconds. The data was gathered during the operational testing of a mystery software system. You can assume that the data is 'clean', collected as per the operational profile, and is as required for software reliability growth modeling.

Please answer all the questions below using brief sentences and/or bullet points. Please write directly on the exam booklet – it may help to mark-up the graphs directly to convey your points. Put your name on this exam paper NOW.

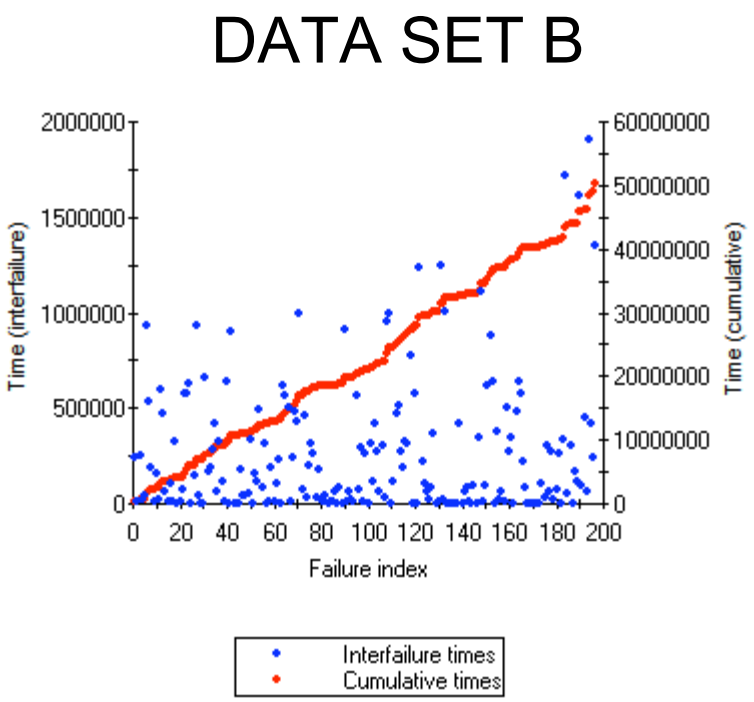
2.1 The following plot shows the raw data plot for an inter-failure time data set (data set A). Explain what this plot tells you about the software system and its reliability. You are to write down EVERYTHING that you think is going to be relevant and important to the analysis you undertake (i.e., anomalies and trends in the testing data, specific data points, etc.)



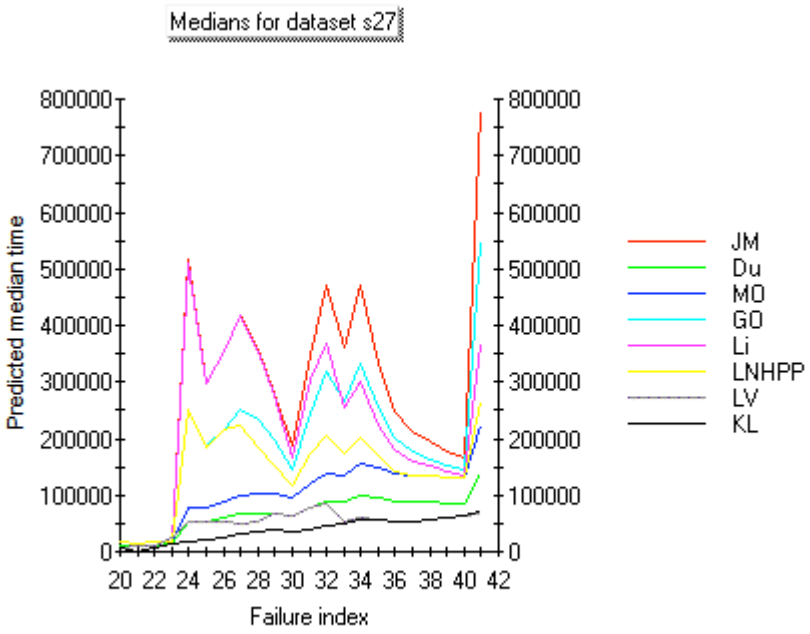
2.2. The following plot shows you an alternative view of the **same** inter-failure time data set (data set A). Explain what this plot tells you. What happens to the slope and why could that be? What can you say about the software reliability and the effectiveness of the testing?



2.3. The following plot shows you an alternative view a **different** set of inter-failure time data (data set B). Explain what this plot tells you about the software system and its reliability. What happens to the slope and why could that be? What can you say about the software reliability and the effectiveness of the testing here?



2.4 The following plot shows the median predictions that result when 8 reliability models are applied to one of the above inter-failure time data sets.

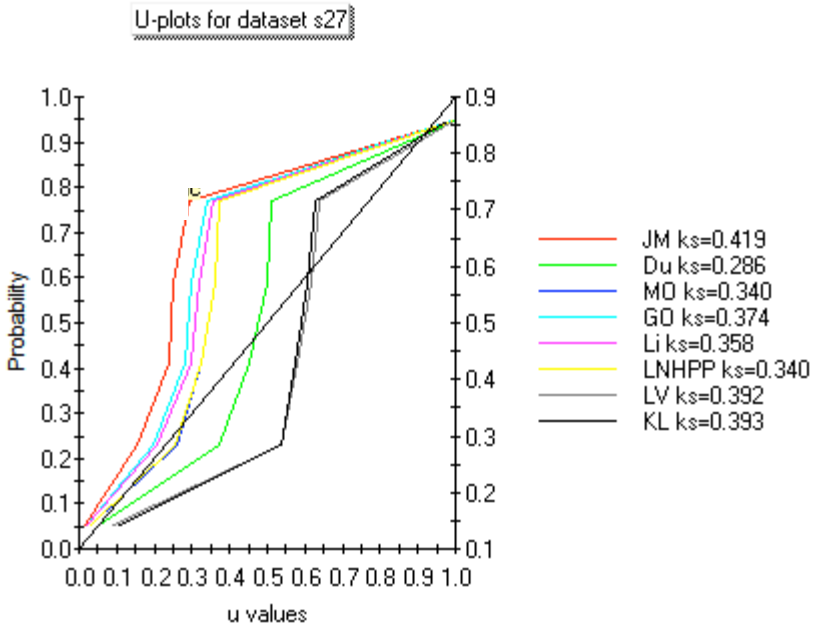


(a) Explain what a median prediction is and what it is used for in software reliability growth modeling.

(b) Discuss what this actual plot tells you about the predictions of the 8 reliability models on this data set. Do you notice any patterns or trends? If so, why could this be? Account for failure index 23.

(c) Suggest which model(s) may be giving the most accurate median predictions. How do you guestimate this?

2.5 The following plot shows the u-plot for the 8 reliability models that have been applied to this inter-failure time data set.



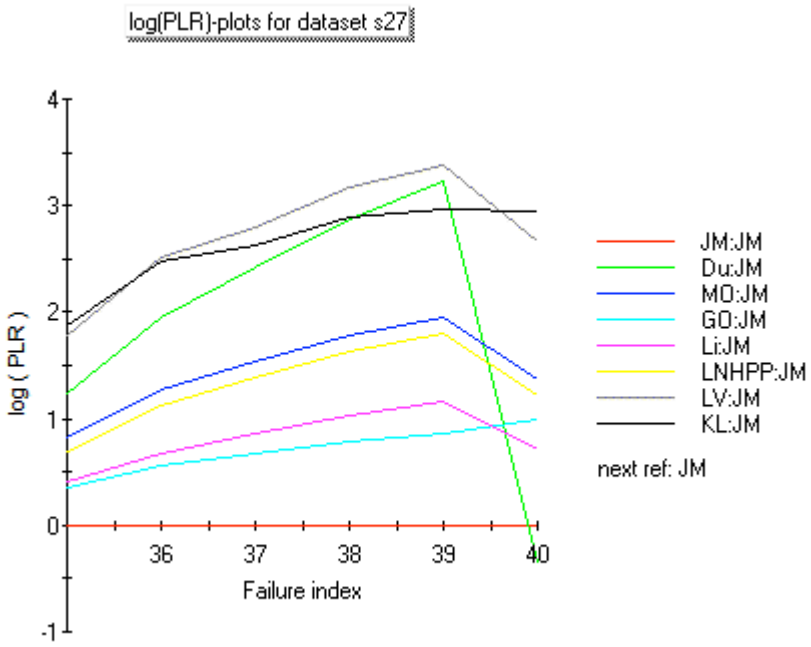
(a) Explain what a u-plot is and what it is used for in software reliability growth modeling.

(b) Discuss what this actual plot tells you about the predictions of the 8 reliability models on this data set.

(c) What extra information does the ks value tell you?

(d) Suggest why the plot is angular (and not smooth). Why do the plots take a similar shape? What does this tell you about the testing data?

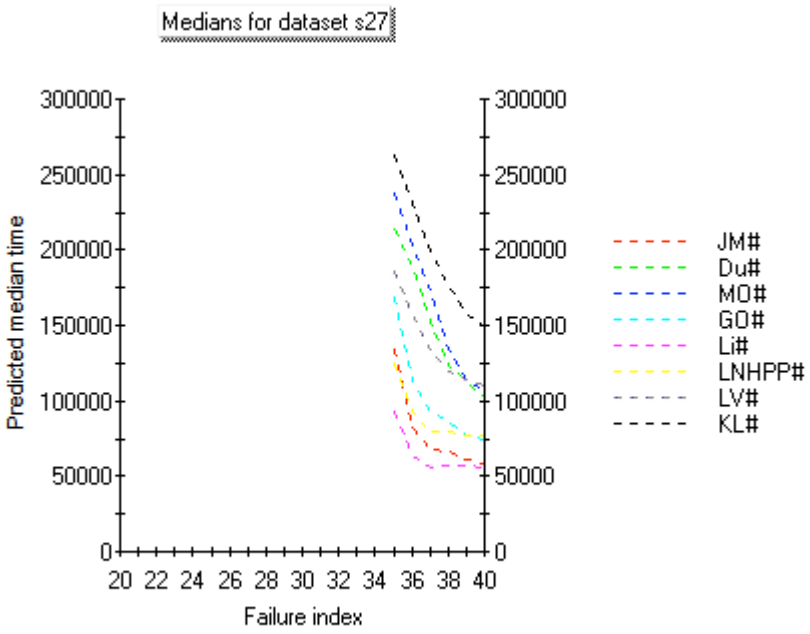
2.6 The following plot shows the log(PLR)-plot for the 8 reliability models that have been applied to this inter-failure time data set, using JM as a reference model.



(a) Explain what a log(PLR)-plot is and what it is used for in software reliability growth modeling.

(b) Discuss what this actual plot tells you about the predictions of the 8 reliability models on this data set.

2.7 The models have now been recalibrated.



(a) Discuss what the above median-plot tells you about the predictions of the 8 recalibrated reliability models that have been applied to this inter-failure time data set. Comment on this new plot in comparison with the raw median-plot given earlier (in question 2.4).

(b) Explain why this plot starts from failure number 35.

2.8 Discuss what the following u-plot tells you about the predictions of the 8 recalibrated reliability models that have been applied to this inter-failure time data set. Comment on this new plot in comparison with the raw u-plot given earlier (in question 2.5).

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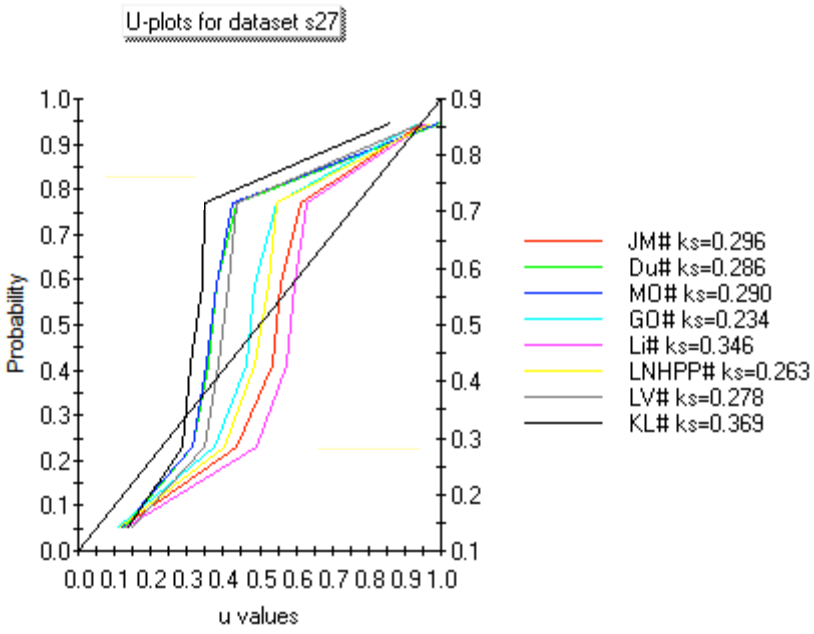
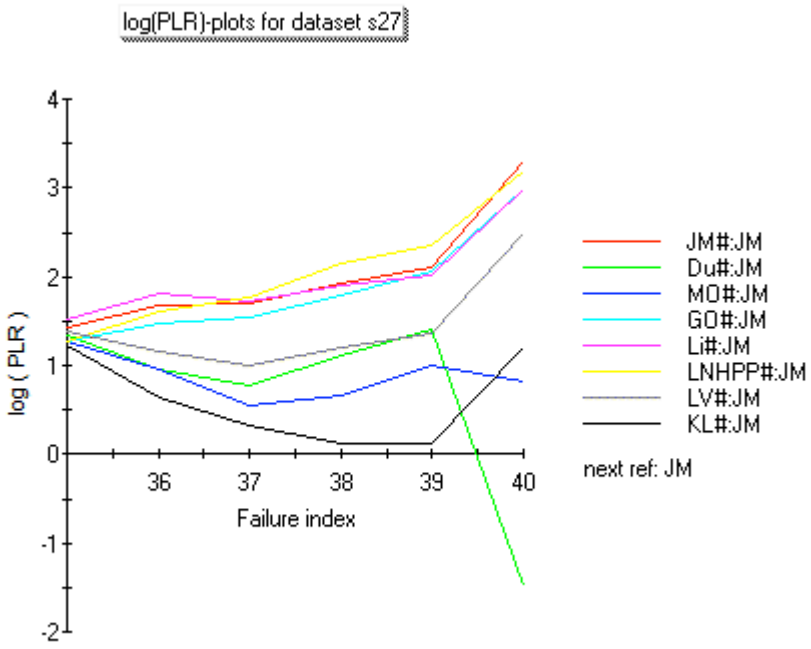


2.9 Discuss what the following log(PLR)-plot tells you about the predictions of the 8 recalibrated reliability models that have been applied to this inter-failure time data set. Comment on this new plot in comparison with the raw log(PLR)-plot given earlier (in question 2.6).



2.10 The above analysis is designed to assess whether the models are giving trustworthy predictions about reliability based on operational testing data. Having undertaken the above analysis, which model would you use with this data set to assess the reliability of the software system under study (using next one-step-ahead type of prediction). Can you trust what this model is telling you about reliability? Justify your answer.

2.11 Which of the two data sets have you just been examining? Data set A or data set B? Explain how you know this.

2.12 Would your answer to question 2.10 above apply with the other data set? Explain your answer.

~~END OF SECTION 2~~

Please double check that you have answered all parts of this section – there are MANY parts

3. Controlling, Assuring and Measuring Quality *[40 points]*

(This is an intentionally open-ended question and there is no text book answer to regurgitate -- it is up to you to be convincing and persuasive in your work. You are expected to draw upon your coursework, the class discussions, the readings you should have read, your global software development project work experiences, your other graduate software engineering prerequisite courses and the topics within the various individual term papers when compiling your response.)

SCENARIO: The GSD MultiLIB project is over. Now is the time for you to reflect on what you have done over the course of the semester: what went well, what didn't go so well and what would you do differently if you were to do the semester over now that you have slightly wider knowledge, more experience and perspective? Consider this a quality retrospective for your personal software process improvement purposes.

3.1 In theory, MultiLIB should be a simple software system that students should be able to understand, develop and deploy. Obviously, the distributed and global nature of the project introduced more complexity into the mix. In doing the project over (with exactly the same schedule and set-up), what do you view as the main risks to quality that would need to be controlled on such a project in such a global setting?

[5 points]

3.2 Put together the **initial notes** for a quality plan. This plan will eventually explain how you are going to go about controlling these risks and, in the process, assure the quality of the MultiLIB project this time round. You are to take the **broader perspective** of an **overarching SQA Manager** for all the teams involved (client, development, coaching and auditing). This plan is intended to consider both the quality of the end-to-end software development process and its products.

You are free to do this task as you see fit. For guidance however, your notes may want to address the following key points directly:

- A statement about the overall quality goals for this project, with some indication as to how you are going to determine whether these goals have been met. (You may consider using the GQM or GAMMA approach to guide you.) What data will you need to gather and how will you do this? Be careful and explicit when you select metrics.

- An analysis of the different ways in which this software system could fail (particularly due to software faults), and the suggested mechanisms for mitigating and/or dealing with failure due to software faults.

- A list of ways to address the other important risks to quality that you identified in your answer to question 3.1.

- The SQA organization you would put in place for the project (i.e., the various roles and responsibilities, checks and balances) and at what levels. Explain the role and value of internal and external auditors, and coaches and mentors for quality, and if you would use them.

- The individual SQA techniques and practices you would use and at what stages of the software development and project management lifecycle. Explain both why and how each of these techniques and practices addresses quality issues. Be detailed and explicit here and avoid simply taking a shopping list approach. [This section should form a large part of your answer and it may help to present techniques and practices as a table explaining what, why, when, how, etc.]

- Remember that you are addressing the quality of the client's work and client/developer relations also – so what would you do to attend to this aspect?

- The types of testing you would do and why, how you would undergo this testing, the data you would collect, what you would do with this data and how you would know when to stop testing. Who would do this testing? How would defects and bugs be handled?

- As you focus on quality, you must ensure that you place the effort where the cost/benefit is best, so consider what you would do with regard:

  - fault prevention practices;

  - fault identification practices;

  - fault removal practices; and

  - fault tolerance/recovery practices.

- State any relevant standards or models you would use this time round and why.

*IMPORTANT: Think about this task very carefully **before** you start writing. I am looking for personal, reflective and considered work. I do not want to see a random list of haphazard thoughts. This is your opportunity to demonstrate YOUR learning and YOUR ability to begin to plan for assuming such a role in the future.*

[30 points]

3.3 Convince me why your eventual quality plan would improve the results of the MultiLIB project this time round. Also, state what is the **most important** thing you would do in your attempt to institute a culture for quality amongst all the students worldwide?

[5 points]

~~END OF SECTION 3~~

4. Selecting Quality Software *[40 points]*

(This is also an intentionally open-ended question and there is no text book answer to regurgitate -- it is up to you to be convincing and persuasive in your work. You are expected to draw upon your coursework, the class discussions, the readings you should have read, your global software development project work experiences, your other graduate software engineering prerequisite courses and the topics within the various individual term papers when compiling your response.)

SCENARIO: The GSD MultiLIB project is over and it was really painful to select the winning software at the end of the day. The procurement of software (i.e., software selection) is a really tough problem in industry – when there are competing bids to choose from, it is not always just about price – it is about selecting the software system that best meets current and future requirements. If these are poorly understood and unclearly specified, we may as well toss a coin.

4.1 How was the quality of each MultiLIB software system assessed at the end of the day on this project? Be as detailed as possible in your answer. Would you say that the quality was **objectively** measured (in an engineering sense)? Would you say that the quality was **effectively** measured for this project? How did quality influence the final decision?

[10 points]

4.2 What were the **4** most critical non-functional requirements (i.e., quality attributes) for MultiLIB in your opinion? Rank these in order of importance (i.e., 1 Most Important through 4 Least Important). Explain your choices and justify their rank ordering. Set a **measurable** target for each. You must justify your targets also. If you find that you are struggling to do this, what steps would you take to find out what would be considered a necessary and sufficient target level for each of these quality attributes?

[12 points]

4.3 Explain how you would go about measuring the **ONE most important** quality attribute that you highlighted in your answer to question 4.2 above (i.e., the one you ranked as priority 1). What data would you have to gather and how would you go about it? How would you propose to use this measure to inform a decision on the quality achieved in each competitive software product at the end of the project?

[10 points]

4.4 Now envisage yourself in industry and forget about MultiLIB for a moment. You are working as an independent consultant and have been asked to advise Pace University on the procurement of a new software system for its library. It has 2 competing products on the table for you to examine. How would you go about this selection process? Importantly, what additional / different considerations are you going to have to factor into your decision making process that did not apply for MultiLIB? Draft a letter to the university to explain how you propose to go about this selection task, while also convincing them that you are qualified to undertake this selection task.

[8 points]

~~END OF EXAM~~