

One and a half hours

Appendices A and B are located at the back of the exam

**UNIVERSITY OF MANCHESTER  
SCHOOL OF COMPUTER SCIENCE**

Software Evolution

Date: Friday 26th May 2017

Time: 09:45 - 11:15

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**Please answer any TWO Questions from the FOUR Questions provided**

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This is a CLOSED book examination

The use of electronic calculators is NOT permitted

**[PTO]**

**Question 1.**

- a) Give three reasons why maintenance of software is considered expensive. [3 marks]
- b) The factors affecting software can be partitioned into four parts, the code itself, the system requirements, the technical platform on which it runs and the business environment in which it operates. For each of these, give an example of a change that will require maintenance of a program. [4 marks]
- c) You are a newly appointed IT manager in a small regional company that manage the supply of ingredients to school kitchens in your area. Your IT department consists of you and one recent graduate who has just joined your company. The two of you are responsible for the software that receives weekly orders from each school and manages the placing of orders with your suppliers and the distribution of the ingredients. A previous employee who has long left the company developed this software in-house. The boss has noticed that more ingredients than are needed are being ordered and has asked to discover why and provide additional daily management reports so that he can more closely monitor what is happening. Excluding the source code, identify with reasons what you believe will be the four most useful sources of information that you could use to understand the system. [4 marks]
- d) The code fragment shown below comes from software that staff in the School of Computer Science use to transfer student information between different systems. Draw a control flow graph for lines 2-22 of the body of the method. [6 marks]

```

1  private void updateAllocation(final Student student) {
2  final List<ActivityAllocation> droppedActivities
3    = new LinkedList<ActivityAllocation>(student.getActivities());
4  for (CourseUnit unit : student.getRegisteredUnits()) {
5    for (ActivityTemplate template : unit.getActivityTemplates()) {
6      final ActivityAllocation allocation
7        = student.findActivityByTemplateName(template.getName());
8      if (allocation != null) {
9        if ((template.getActivities().size() > 1)
10           || unit.equals(getTutorialCourseUnit())) {
11          droppedActivities.remove(allocation);
12        }
13      } else if ((template.getActivities().size() > 1)
14                || unit.equals(getTutorialCourseUnit())) {
15        final ActivityAllocation newActivity
16          = getCreateActivityAllocation(student, template);
17        student.getActivities().add(newActivity);
18        logger.info(...);
19      }
20    }
21  }
22
23  for (ActivityAllocation drop : droppedActivities) {
24    student.getActivities().remove(drop);
25    logger.info(...);
26  }
27  }

```

(Question 1 continues on the next page)

Question 1 (continued)

- e) Once a modification of a system has been implemented and tested, it needs to be deployed. Outline the risks associated with deployment and how they can be mitigated.  
[4 marks]

[PTO]

**Question 2.**

- a) When comprehending a system there are three elements that a user exploits, knowledge of the application domain, existing knowledge of the system and general programming knowledge. Explain how each of these affects a programmers understanding of a system. [3 marks]
- b) When attempting to understanding low-level code, part of the way this is achieved is by identifying idioms and patterns in the existing code. Briefly, outline what an idiom or pattern is and then explain why there are useful to the understanding of code. [3 marks]
- c) Identify the idioms or patterns present in the code fragment shown in Question 1, section d) and identify what they are achieving. [5 marks]
- d) One of the skills that a maintenance engineer must have is coping with unfamiliar languages. The code on the next page comes from the Wikipedia page on COMTRAN, a business oriented programming language.
- i) Identify three characteristics of this language or questions you would need to answer to understand it. For each of these, set them in terms of general programming knowledge that you have. [6 marks]
- ii) Identify three domain related issues or questions that the code raises in your mind. For each of these, justify why you think this is a valid issue or question. [3 marks]

(Question 2 continues on next page)

## Question 2 (continued)

```

01001 *PROCEDURE

01002 CALL (EMPLOYEE.NUMBER) EMPLOYNO,
01003         (BONDEDUCTION) BONDEDUCT,
01004         (BONDENOMINATION) BONDENOM,
01005         (BONDACCUMULATION) BONDACCUM,
01006         (INSURANCE.PREM) INSPREM,
01007         (RETIREMENT.PREM) RETPREM,
01008         (DEPARTMENT.TOTAL) DPT.

01009 START. OPEN ALL FILES.

01010 GET.MASTER. GET MASTER, AT END DO END.OF.MASTERS.

01011 GET.DETAIL. GET DETAIL, AT END GO TO END.OF.DETAILS.

01012 COMPARE.EMPLOYEE.NUMBERS. GO TO COMPUTE.PAY WHEN DETAIL EMPLOYNO
01013         IS EQUAL TO MASTER EMPLOYNO, LOW.DETAIL WHEN DETAIL
01014         EMPLOYNO IS LESS THAN MASTER EMPLOYNO.

01015 HIGH.DETAIL. MOVE 'M' TO MASTER ERRORCODE, FILE MASTER IN
01016         ERROR.FILE.

01017         GET MASTER, AT END DO END.OF.MASTERS.

01018         GO TO COMPARE.EMPLOYEE.NUMBERS.

02001 LOW.DETAIL. MOVE 'D' TO DETAIL ERRORCODE, FILE DETAIL IN
02002         ERROR.FILE.

02003         GO TO GET.DETAIL.

02004 END.OF.MASTERS. IF DETAIL EMPLOYNO = HIGH.VALUE THEN GO TO
02005         END.OF.RUN OTHERWISE SET MASTER EMPLOYNO = HIGH.VALUE.

02006 END.OF.DETAILS. IF MASTEREMPLOYNO = HIGH.VALUE THEN GO TO
02007         END.OF.RUN OTHERWISE SET DETAIL EMPLOYNO = HIGH.VALUE, GO
02008         TO COMPARE.EMPLOYEE.NUMBERS.

02009 END.OF.RUN. MOVE CORRESPONDING GRAND.TOTAL TO PAYRECORD, FILE
02010         PAYRECORD, CLOSE ALL FILES.
02011         STOP 1234.

02012 COMPUTE.PAY. IF DETAIL HOURS IS GREATER THAN 40 THEN SET DETAIL
02013         GROSS = (DETAIL HOURS - 40) * MASTER RATE * 1.5.

02014         SET DETAIL GROSS = DETAIL GROSS + MASTER RATE * 40, DO
02015         FICA.ROUTINE, DO WITHHOLDING.TAX.ROUTINE.

02016         IF MASTER BONDEDUCT IS NOT EQUAL TO ZERO THEN DO
02017         BOND.ROUTINE.

02018         DO SEARCH FOR INDEX = 1(1)12.

02019 NET. SET PAYRECORD NETPAY = DETAIL GROSS - DETAIL FICA - DETAIL
02020         WHT -DETAIL RETIREMENT - DETAIL INSURANCE - DETAIL
02021         BONDEDUCT.

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[PTO]

**Question 3.**

An online retailer of men's clothes is taking over a chain of bespoke dress shops. One reason for this takeover is to allow the company to offer a wider range of products. However, it will also mean that they can offer men a try-before-you-buy service and that the bespoke dresses are available to a wider customer base. As part of the takeover, it is planned to merge the IT systems of these companies. The architecture of the reasonably modern online retailers' IT system is shown in Appendix A; this is focussed on online sale and handling the dispatch of goods to customers. The architecture of the dress shops' IT system is focused on the shops and gaining information from the designers who provide the dresses sold. It is shown in Appendix B; notably it does not support any management reports on the operation of the business.

You are the IT manager for the online retailer. Your deputy is overseeing the current systems, and you have been assigned the role of merging your IT services with those of the dress shops. You have a report from IT consultants on merging the systems that suggests three options: 1) mutual limited query access between the two original IT systems, 2) migrating dress shop data into your current system and then continuing to use this system, and 3) developing a new combined IT system.

- a) Your first task is to assess each of the consultant's options, (for example in terms of cost, complexity, and speed of deployment), and to recommend to the board, with justifications, which of them should be followed. [6 marks]
- b) If option 2, migration to online retailers system, was selected for supporting the combined business, describe the process via which you would achieve this with no data being lost and all existing data being available to staff. [5 marks]
- c) If option 3, new system, was chosen, your second task would be to define the architecture of the combined IT system. Outline an architecture that could result from this task; assumptions that you make should be stated and the board will want justification for your recommended architecture. [4 marks]
- d) Assume that your architecture from part c) is accepted and that a forward migration strategy will be used to migrate the current systems to this new architecture. Outline how you plan to do this; your plan should clearly identify the order in which elements of the system are migrated with a justification for this order. [5 marks]

**Question 4.**

- a) Just as software evolves, so do the techniques that are used to develop and define programs. For the two definition techniques listed below, briefly outline how the technique works and then describe the advantages of using the technique.
- i) Aspect Oriented Programming (AOP) [4 marks]
  - ii) Dependency Injection (DI) [4 marks]

- b) You are head of the IT section of a construction firm that is currently using some in-house software to analyse the structure of the buildings that you construct. As this was developed many years ago when your firm was much smaller and there were less legal processes to be fulfilled, it is best described as “no longer fit for purpose”. Thus, you are considering the development of a new version of the system that will fulfil your current requirements.

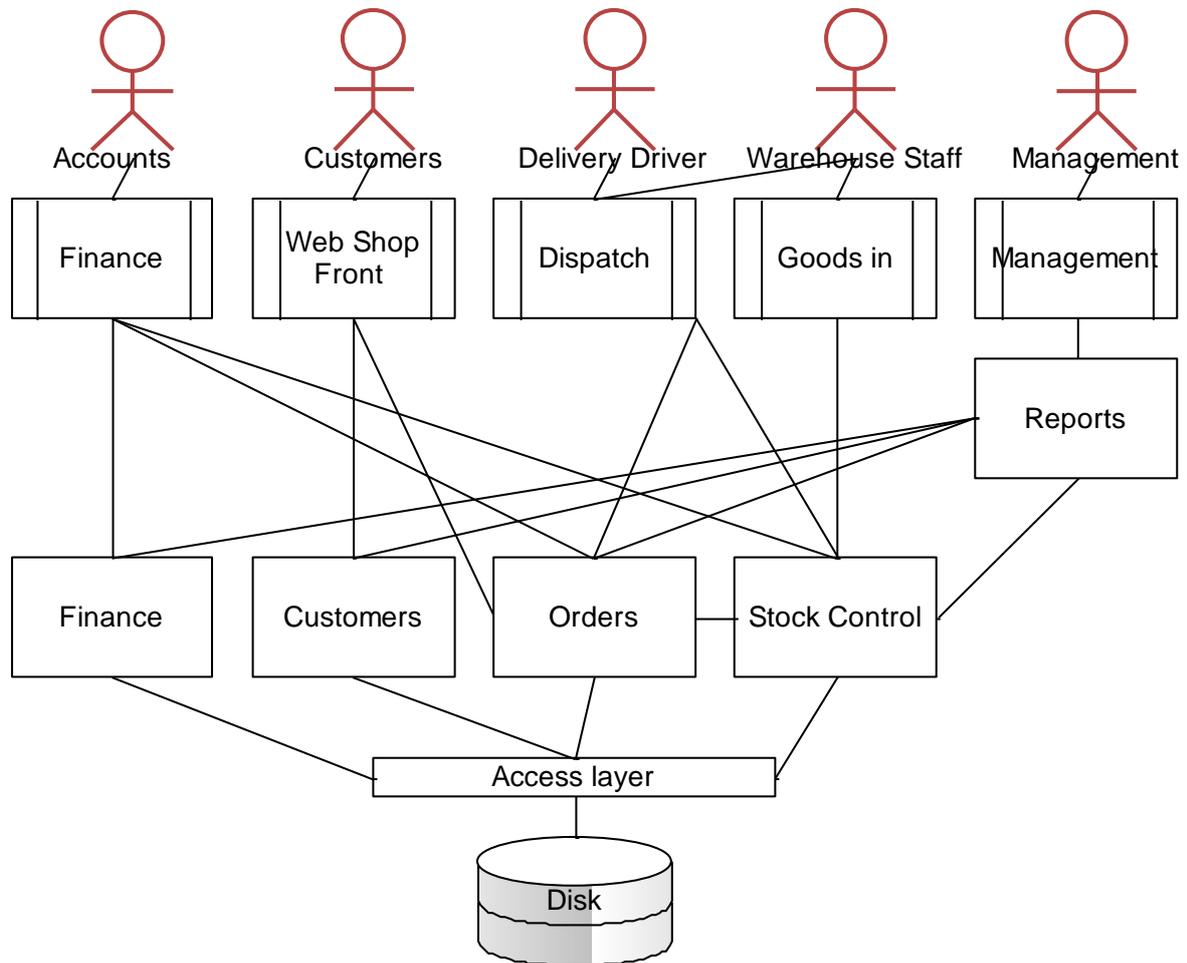
It has come to your attention that another company has an implementation of a similar program that you could license; experience within the construction industry suggests that this implementation is reliable. However, it does not do precisely your firm’s requirements and your team would need to implement some small special tools around to make it fulfil your needs.

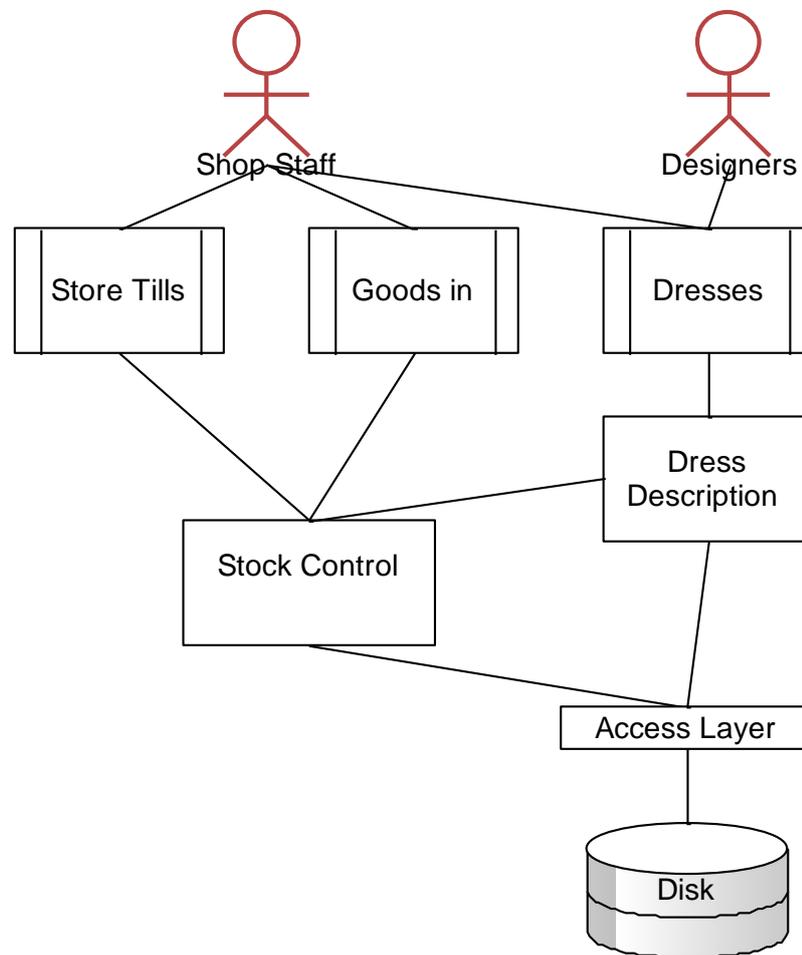
You have also heard that the development of an open-source program that is attempting to provide similar functionality has recently started. Thus, you could also consider contributing to and using this software.

You need to evaluate each of these options and decide which is best for your company. Before doing so, you must define the criteria that this assessment will use. These must address the total cost of ownership of each option and the risk to the company. Outline with justifications, what you think these criteria should be. [6 marks]

- c) Now apply the criteria that you have defined to the options listed in section b) to produce a reasoned argument to your management on the option to follow. [6 marks]

[PTO]

**Appendix A – Supermarket's IT System Architecture**

**Appendix B – Convenience Store’s IT System Architecture****END OF EXAMINATION**