2B11 Sample Exam Paper
2.5 Hours

This sample paper illustrates the structure of the real exam paper and the style of the questions. The real paper will have the same two part structure, and the same number of questions.

Note that Part I is compulsory and accounts for 50% of the marks. A question on compilers, as taught by John Washbrook, is included in the compulsory part and is worth 20 marks.

Answer ALL questions from Part I and TWO questions from Part II

Part I

1. a) What are the key properties of a container class? How do containers store objects?

    [4 marks]

    b) Write a Java interface declaration for type Set.

    [4 marks]

    c) *Outline* the design of a Set class in Java that implements your Set interface. Provide the full set of methods needed to ensure that Set objects can be created, copied and accessed correctly. Assume Set objects will only be used by a single thread. (Complete Java code is not required.)

    [10 marks]

    d) A Set object may be used by multiple threads. How should your class be modified to be thread-safe (i.e., so that it can be accessed by multiple threads)?

    [6 marks]

    e) Outline a test plan for your thread-safe Set class.

    [6 marks]
    [Total 30 marks]

2. a) The following SR-table was derived from the output produced by yacc from the input

   %%
   list : list ',' 'x'
   list : 'x'

input state	ACTION			GOTO
	x	,	$end	list
0	s2			1
1		s3	accept	
2	r2	r2	r2	
3	s4			
4	r1	r1	r1	

Explain how the entries s2 and r2 are to be interpreted. Also explain how a blank entry is to be interpreted.

[3 marks]

Show the moves which the parser would make when parsing the sentence

x_1 , x_2 , x_3

[5 marks]

Construct the corresponding parse tree, labelling each node with the number of the corresponding move from the parse.

[4 marks]

b) The following two augmented grammars are expressed in yacc:

```
list  :  list  INT  {print($2);}
      |
```

```
list  :  INT list {print($1);}
      |  INT
```

i)   From each grammar derive a parse tree for the sentence 1 2 3
       (which when tokenised becomes INT INT INT). By traversing that
       tree show the results of executing the print actions.

ii)   Explain why, when using yacc, left recursion may be preferred for
       the definition of simple lists.

iii)   Explain why left recursion is appropriate for the definition of simple
       arithmetic expressions.

iv)   Left recursive grammars are not appropriate as a basis for the
       construction of recursive-descent parsers. Explain why this is so.

Give another instance of a circumstance in which a left-recursive definition would
not be appropriate.

[8 marks]

[Total 20 marks]

End of Part I

3

Part II

Answer Two questions

3.

In the following two fragments of Java program it is assumed that a variable **n** has been declared and given a value.

do-while 1:

```
do
    System.out.print("*");
while (n-- > 0);
```

do-while 2:

```
do {
    System.out.print("*");
    n--;
} while (n > 0);
```

i)   For each fragment, express as a function of n the number of times the print statement is called.

ii)   Show the kind of target code for execution on a stack-based machine which might be generated from the second fragment. Translate `System.out.print("*");` as `print "*"`

iii)   Draw a syntax diagram for the *do-while* construct. You may assume that *expression* and *statement* are already defined.   State any further assumptions you make.

iv)   Annotate your syntax diagram to generate code for a stack machine.

Write a Java method implementing your annotated syntax diagram. State the purpose of any other methods or variables to which you refer.

Your implementation should work for nested constructs; briefly justify that it does.

[Total 25 marks]

4.   a) Describe the role of design patterns in the design and programming process. What benefits do you hope to gain from exploiting patterns?

[10 marks]

b) Describe a high level design for a text editor program in terms of patterns. For each pattern used, provide a short description of the pattern using a suitable template.

[15 marks]

[Total 25 marks]

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5. a) When constructing a Graphical User Interface (GUI), what are the roles of components, panels and layout managers?

[7 marks]

b) What is event handling and how does it work?

[7 marks]

c) Outline the structure of the GUI for a web browser. How are the components assembled and how is event handling managed?

[11 marks]

[Total 25 marks]

END OF SAMPLE PAPER

Additional example questions:

A1. a) What are architectural patterns? Provide an example and discuss how they relate to design patterns.

[10 marks]

b) A Java program needs to be written that will use large numbers of data objects, many of which will have the same value for all or part of the execution of the program. Lists and arrays will be used to store the objects. Memory use and the overhead of copying data objects needs to be kept to a minimum.

Put forward a set of recommendations on the design of the program, focusing on the need to manage the data objects effectively. Clearly indicate what patterns or idioms should be used, giving implementation examples.

[15 marks]

[Total 25 marks]

A2. Consider the design of an application to create and edit software engineering diagrams (such as class diagrams). Making use of Design Patterns outline:

a) The core data structures needed to represent a diagram, along with the methods by which they are created and accessed.

[10 marks]

b) The elements needed to provide a display window, menus, command handling and scrollbars.

[15 marks]
[Total 25 marks]

A3. a) Describe the Java exception handling mechanism.

[5 marks]

b) Consider a CharacterBuffer class whose instance objects read data one character at a time from a file, storing the characters in an internal buffer. Clients of the class can then read either single characters or an array of characters. Exceptions should be thrown whenever an invalid buffer operation is performed (such as attempting to read an from an empty buffer).
Describe the implementation in Java of the class (exact Java code is not required), with emphasis on the exception handling. Include an exception class to represent exceptions that are thrown by the CharacterBuffer class.

[15 marks]

c) Show how a client would use an instance of the CharacterBuffer class.

[5 marks]
[Total 25 marks]

A4. a) What is a design pattern? Describe an example pattern to illustrate your answer.

[8 marks]

b) What is software architecture? What role does architecture play in software development?

[8 marks]

c) Outline the relationships between design patterns, architecture and the idea of layers of change. How do these relationships help to design a system?

[9 marks]
[Total 25 marks]