Welcome to the Practice Exam. Today only you can talk during the exam with whoever is sitting next to you. Tomorrow this won’t be allowed. At the end of the exam I am going to ask you to write down what (if any) kind of reference sheet you would have wanted to be provided. For this purpose today only during this practice test you can also consult your notes (or someone else’s notes) or laptops. Again, this is so we can determine what, if any, reference sheet I should provide tomorrow.

Remember: Whenever we say to "design a function", we mean that you need to follow the design recipe. Any other time that you need to write a function on this exam (or in this class for that matter) you also need to follow the design recipe.

1. Please write the following expression in BSL notation also providing a check-expect for a suitable value of any variables involved:

$$\sqrt{1 - a^2}$$

2. Please describe the signatures and the purpose statements of the following BSL functions: beside, above. Please refer to the code provided on the right.

3. Write BSL code to produce this red plus on white background:

4. Explain how you’re going to design this boat. Don’t write code just what you plan to use (functions, geometric shapes, etc.) and where.

5. Define the function `string-last`, which extracts the last character from a non-empty string. Don’t worry about empty strings.

6. Design a function that translates a letter grade to a number. Acceptable letter grades are: A, B, C, D and F. Your function should produce a 4 for A, a 3 for B, a 2 for C, a 1 for D, a 0 for F and a -1 for any other input received.
7. Assume that \( a \) and \( b \) have boolean values. Simplify: \((\text{and } a \ (\text{or } a \ b))\)

8. Prove that \((\text{or } a \ (\text{and } a \ b))\) is equivalent to \( a \) if \( a \) and \( b \) are arbitrary booleans.

9. Design a function \text{swap} that receives a non-empty string and returns a string in which the first and last characters of the input have been swapped. For example if input \text{hoop} is received the string returned by the function would be \text{pooh}; if input \text{no} is received the output would be \text{on}. Don’t worry about empty strings.

10. Write down the names of the functions (constructors, selectors and predicates) that the following structure type definitions define:

\[
\text{(define-struct movie \[title producer year\])}
\]

11. Write the template for a function that would have to process this type of structures.

12. A point is a pair of two numbers. A circle is a point with a radius (a number). A triangle is represented by three points. Write data and structure definitions for point, circle and triangle. Construct some examples.

13. The euclidian distance between two points \((x_1, y_1)\) and \((x_2, y_2)\) can be calculated with the formula
\[
\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}.
\]
Design a function \text{distance} that takes two points as defined above and returns the distance between them.

14. The area of a circle with radius \( r \) can be calculated with this formula: \( \pi r^2 \). \( \pi \) is available in BSL as \text{pi}. Design a function \text{circle-area} that receives a circle as defined above and returns the calculated area of the circle.

15. The area of a triangle whose sides have lengths \( a, b, c \) can be calculated with Heron’s formula:
\[
\sqrt{s (s - a)(s - b)(s - c)} \text{ where } s = \frac{a+b+c}{2}.
\]
Design a function that receives a triangle as defined above and returns its area.

16. Design a data definition for \text{ManyNumber}. Such a data type is either a (possibly empty) list of numbers or uses structures definitions to emulate a (possibly empty) list of numbers. Give some examples.

17. Design a function (call it \text{generate}) that takes a number \( n \) and produces a value of \text{ManyNumber} type containing random integers between \(-50\) and \(50\).

18. Design a function (call it \text{add}) that takes a \text{ManyNumber} as an argument and returns the sum of all its even elements.

19. Design a function (call it \text{filter}) that takes a \text{ManyNumber} as an argument and returns the \text{ManyNumber} comprised of only its even numbers.

20. Give an example of a simple, short, but complete \text{big-bang} program.