

1. 10%

Write an equivalent Lisp expression for

$$\frac{\tan(x - y * \cos(y))}{\sin(x+y)}$$

where x, y, sin, cos, and tan have been defined somewhere.

2. 15%

- a) Write a procedure, (big2 a b), which returns the bigger one of a and b.  
 b) Using previous big2 to write a procedure, (big3 a b c), which return the biggest one of a, b, and c.  
 c) Using previous big3 to write a procedure, (big4 a b c d), which return the biggest one of a, b, c, and d.

3. 10% + 10%

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(let ((x (* y 5))
      (y (+ x 2))
      (z (+ x y)))
  (* (- x y) z))
```

 $a \geq b$ 

- a) For the above 'let expression', write its equivalent 'lambda form'.  
 b) With x=3, y=2, and z=4, evaluate the above 'let expression'.

4. 10% + 10%

A function f defined for non-negative integers is defined as:

f(n) = 8, if n=0  
 1, if n=1  
 9, if n=2  
 f(n-1) - f(n-2) + f(n-3), if n>2 and n is odd  
 f(n-1) + f(n-2) - f(n-3), if n>2 and n is even

- a) Write a procedure that computes f in linear recursive way.  
 b) Write a procedure that computes f in linear iterative way.

You may assume even? and odd? are available.

5. 5% + 15%

Assume that a binary operator &lt;\*&gt; which does something like:

 $a <*> b = a * b + a + b$ 

- a) Prove that this operator is associative.  
 b) Write a procedure, (fast-bn b n), which calculates  $b <*> b <*> \dots b$ , i.e., n b's combined with <\*>. The procedure should run in  $O(\log n)$  time.

&gt; (fast-bn 3 0)

0

> (fast-bn 3 1)  $3 + 0.3$   $(a + b + a)^n$ 

3

> (fast-bn 3 2)  $3^2 + 3 + 3$ 

15

> (fast-bn 3 4)  $3^3 + 3 \cdot 3 \cdot 3 + 3 + 3 + 3$ 

255

&gt; ,exit

 $3^4 + 3 \cdot 3 \cdot 3 \cdot 3$ 

6. 10% + 5%

- a) Write a procedure, (filtered-sum filter a b), which calculates the sum of { x | a ≤ x ≤ b and filter(x) }.  
 b) Using previous 'filtered-sum', write a procedure, (modsum a b m), which calculate the sum of multiples of m, which are between a and b.

> (modsum 1 8 3)  $3 \times 6$ 

9

&gt; (modsum 1 8 2)

20

&gt; ,exit

 $2 \times 4 + 6 + 8$