

- Answer these questions individually. You may only use the book, the homework, the class notes, the class website, and the ACL2 documentation. You may ask for help only from the instructor.
- Email your solutions to me at `cowles@uwyo.edu`.
- The subject line should identify the problem set, i.e. Exam Question 2.
- The body of the message should be a Lisp readable file in simple ascii text format.
- The first few lines of the body should contain your name.

Exam Question 2. The Meyer and Ritchie version (1967) of Ackermann's function may be defined recursively on the nonnegative integers by

```
ack-mr(x,y) <== if y=0 then 1
                else if x=0 and y=1 then 2
                else if x=0 and y>1 then y+2
                else ack-mr( x-1, ack-mr(x,y-1) ).
```

1. Define `ack-mr` in ACL2.
2. Prove each of the following in ACL2, for all nonnegative integers  $x$  and  $y$ .
  - (a) `ack-mr(x,0) = 1`.
  - (b) `ack-mr(x,1) = 2`.
  - (c) `ack-mr(x,2) = 4`.
  - (d) `ack-mr(0,y) = if y=0 then 1`  
`else if y=1 then 2`  
`else 2+y`.
  - (e) `ack-mr(1,y) = if y=0 then 1`  
`else 2*y`.
  - (f) `ack-mr(2,y) = exp(2,y)`.
  - (g) `ack-mr(3,y) = iter-exp(2,y)`, where  
`iter-exp(x,y) = if y=0 then 1`  
`else exp(x,iter-exp(x,y-1))`

Hint: Read about a different version of Ackermann's function in these files on the class website.

`proof-lesson3.lisp`, `proof-lesson4.lisp`, `proof-lesson5.lisp`