University of California at Berkeley
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Quiz 7 Solutions

*Q*uiz was graded for correctness of equations, not the numerical answer

1. We are using a 400x200 pixel display operating at 10 FPS (frames per second).

   (a) (2 pts) If we are using 4-bit color, what is the data rate going to the video interface?
   $400 * 200 pixels/frame * 10 frame/sec * 4 bits/pixel = 3.2 * 10^6 bits/sec$

   (b) (5 pts) What frequency should the PixelClock be for the 400x200 10-FPS display?
   let w=pixels/line, h=lines/frame, pf=pixel frequency(unknown), hb=horiz blanking interval, vb=vertical blanking interval, fr=frame rate
   Each frame takes 1/fr time. Set this equal to the time to draw every line, including the horizontal blanking interval after each line and the vertical blanking interval at the end of the frame.
   $h * (w/pf + hb) + vb = 1/fr$
   $200 * (400/pf + 10\mu s) + 10ms = 1/10$
   $pf = 400/((1/10 - 10 * 10^{-3})/200 - 10 * 10^{-3})$
   $pf = 909090.9091Hz$
   Another way to think about the problem is that there is 1/10 of a second minus blanking intervals to draw the 400x200=80000 pixels in one frame.
   $drawtime = 1/fr - h * hb - vb$
   $pf = pixels/drawtime = (400 * 200)/(1/10 - 200 * 10 * 10^{-6} - 10 * 10^{-3})$
   $pf = 909090.909 pixels/sec$

   (c) i. (2 pts) What is the horizontal blanking interval in terms of number of pixels?
   Part (b) mentioned that the horizontal blanking interval is like writing extra offscreen pixels at the end of each line. We know the pixel frequency from (b) and just multiply this by the horizontal blanking interval to get how many pixels.
   $pf * hb$
   $909090.9091 pixel/sec * 10\mu s$
   approximately 9 pixels

   ii. (1 pt) What is the vertical blanking interval in terms of number of lines?
   Part (b) mentioned that the vertical blanking interval is like writing extra offscreen lines at the end of each frame. We know the time per line (including blanking interval) by plugging in the pixel frequency. Divide the vertical blanking interval by time per line to get number of lines.
   $vb/(w/pf + hb)$
   $10 * 10^{-3}/((400 pixels/line)/(909090.9091 pixels/sec) + 10 * 10^{-6})$
   approximately 22 lines