



Programming Lab #4d

Automobile Tire Sizes

Topics: Integer arithmetic.

Prerequisite Reading: Chapters 1-5

Revised: November 30, 2020

Background: Automobile tire sizes use a combination of metric and English units and a percentage. For example, a typical tire might be specified as 225/45R17. The first number (225) is the tire's width in *millimeters*. The second number (45) is the tire's aspect ratio; this *percentage* represents the ratio of the sidewall's height to the tire's width. The last number (17) is the diameter of the metal rim in *inches*. The overall diameter of a tire is thus the rim diameter plus twice the sidewall height. I.e., the diameter of a 225/45R17 tire is given by:

$$17 + 2 \times \left(\frac{45}{100} \times \frac{225}{25.4} \right) \text{ inches.}$$

Assignment: Create ARM assembly functions for the diameter and circumference in inches:

```
uint64_t TireDiam(uint32_t W, uint32_t A, uint32_t R) ;
uint64_t TireCirc(uint32_t W, uint32_t A, uint32_t R) ;
```

where W is the tire width in millimeters, A is the aspect ratio (an integer less than 100), and R is the rim diameter in inches. Since you will be using integer arithmetic, you won't be able to return values that have a fractional part. Instead, each function computes two 32-bit values and returns them as a single 64-bit number:

$$\text{Diameter} = R + 2 \times \frac{A}{100} \times \frac{W}{25.4} = R + \frac{2 \times A \times W}{2540} = R + \frac{A \times W}{1270}$$

$$\left. \begin{aligned} D_{63-32} &= R + \text{Quotient of } \frac{A \times W}{1270} \\ D_{31-00} &= \text{Remainder of } \frac{A \times W}{1270} \end{aligned} \right\}$$

The most-significant half of the return value is the integer part of the result; the least-significant half determines the fractional part.

$$\text{Circumference} = \pi \times \text{diameter} = \pi \times \left(D_{63-32} + \frac{D_{31-00}}{1270} \right)$$

$$= 3.1416 \times \left(\frac{1270 \times D_{63-32} + D_{31-00}}{1270} \right)$$

$$= \frac{4987290 \times D_{63-32} + 3927 \times D_{31-00}}{1587500}$$

$$C_{63-32} = \text{Quotient of } \frac{4987290 \times D_{63-32} + 3927 \times D_{31-00}}{1587500}$$

$$C_{31-00} = \text{Remainder of } \frac{4987290 \times D_{63-32} + 3927 \times D_{31-00}}{1587500}$$

The main program (download from [here](#)) converts these results into real numbers and displays the diameter, circumference and revolutions per mile with two fractional digits.



ARM Assembly
for Embedded Applications

Tire Width: -165+

Aspect Ratio: - 65+

Rim Diameter: - 15+

Tire Diameter: 23.44

Circumference: 73.65

Revs Per Mile: 860.23

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