Another example: Let's consider again the continuous random variable X that has density $f_X(x) = (1/4)x^3$ for $0 < x < 2$, and $f_X(x) = 0$ otherwise. Find $E(1/X)$. We recall,

$$E(g(X)) = \int_{-\infty}^{\infty} g(x) f_X(x)\, dx$$

In this case, the density is only nonzero for $0 < x < 2$. Also $g(X) = 1/X$. So we have

$$E(1/X) = \int_0^2 (1/x)(1/4)x^3\, dx = 1/4 \int_0^2 x^2\, dx = (1/4)x^3/3|_{x=0}^2 = 2/3.$$

Here's another example. Suppose we want to compute $E(1/X^2)$. We compute:

$$E(1/X^2) = \int_0^2 (1/x^2)(1/4)x^3\, dx = 1/4 \int_0^2 x\, dx = (1/4)x^2/2|_{x=0}^2 = 1/2.$$

One thing to really emphasize here is that

$$E(1/X) \neq 1/E(X).$$

That's a very common mistake. In this case, $E(1/X) = 2/3$. We also saw earlier that $E(X) = 8/5$, so $1/E(X) = 5/8 \neq E(1/X)$.

Similarly, we have $E(1/X^2) = 1/2$. On the other hand, $E(X^2) = 8/3$, so $1/E(X^2) = 3/8 \neq E(1/X^2)$.

Those are really common errors, and please try to avoid such things. This is kind of like the fact that expected value of X^2 is not necessarily equal to the square of the expected value of X, i.e., $E(X^2)$ is not necessarily equal to $(E(X))^2$.