Re: exponential equation with constant

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- *From*: israel@xxxxxxxxxxx (Robert Israel)
- *Date*: 2 Jun 2005 21:26:27 GMT

In article <1117738290.754362.276360@xxxxxxxxxxxxxxxxxxxxxxxxxxxx>,
<quiasmox@xxxxxxxxx> wrote:
> I had a problem in an electrical circuits class, which was to find the
>point at which the voltage on two exponential curves is equal. These
>were the decaying voltage on an inductor and the rising voltage on a
>capacitor, the curves starting from a fixed voltage and from zero
>(respectively) at the same instant. The equated formulas were
>VL = 2* exp(−2000t) = 1 − exp(−1000t) = VC
>By luck, I found I could solve it for t by turning it into a quadratic−
>let y = exp(−1000t)
>2y^2 + y − 1 = 0 = (2y−1)(y+1)
>Then, using (2y−1),
>2 exp(−1000t) = 1,
>ln(2) = 1000t
>t = 693.2 us.

>This solution depends on the coincidence that one exponent is exactly
>twice the other.
>This brings me to the question −− is there a way, other than computer
>simulation, to solve a*exp(−ct) = 1 − b*exp(−dt) for t?

Similar to your solution: let x = exp(−ct). Then you want to solve
a*x + b*x^e = 1 where e = d/c. I'll assume e > 1 (if e < 1 you can
interchange the terms a*exp(−ct) and b*exp(−dt)). In only a few cases
you have a polynomial equation that can be solved using radicals.
However, at least if b/(a^e) is small there is a series solution

x =
1/a sum_{n=0}^infty (−1)^n GAMMA(ne+1)/(n! GAMMA(n(e−1)+2)) (b/a^e)^n

If e is rational, this can be expressed in terms of hypergeometic
functions.

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- ***Follow−Ups***:
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        - *From:* David W . Cantrell
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        - *From:* quiasmox
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