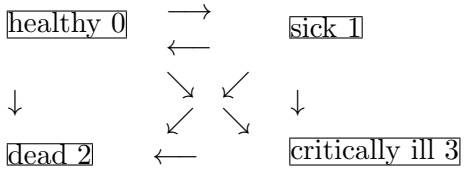
Life Insurance and Finance (STK4500)
Exercises 5, 19.3.2026

Problem 1 Let us consider an insurance policy model which combines benefits of a disability income insurance (see Exercises 2, Problem 1) and benefits in the case of critical illness:



The transition intensities are given by

$$\mu_{01}(t) = a_1 + b_1 \exp(c_1 t), \mu_{02}(t) = a_2 + b_2 \exp(c_2 t),$$
$$\mu_{12}(t) = \mu_{02}(t), \mu_{32}(t) = 1.2 \cdot \mu_{02}(t),$$
$$\mu_{10}(t) = 0.1 \cdot \mu_{01}(t), \mu_{03}(t) = 0.05 \cdot \mu_{01}(t), \mu_{13}(t) = \mu_{03}(t)$$

with

$$\begin{aligned} a_1 &= 4 \cdot 10^{-4}, b_1 = 3.5 \cdot 10^{-6}, c_1 = 0.14 \\ a_2 &= 5 \cdot 10^{-4}, b_2 = 7.6 \cdot 10^{-5}, c_2 = 0.09. \end{aligned}$$

Use the Euler approximation scheme with step size $h = \frac{1}{12}$ (1 month) to compute $p_{00}(x, x+35)$ for an insured aged $x = 30$ years.

Problem 2 Consider a 10−years disability income insurance issued to a healthy life aged 60 years. Payments of 20000$ are provided by the insurer (continuously in time), while the insured is in the disabled state. A death benefit of 50000$ is immediately payable on death. Further, it is also required that premiums are payable continuously, while the insured is in the healthy state. Assume that $\delta = 5\%$ (intensity rate) and that other expenses are ignored.

The transition rates are given by

$$\mu_{*\diamondsuit}(t) = a_1 + b_1 \exp(c_1 t), \mu_{\diamondsuit *}(t) = 0.1 \cdot \mu_{*\diamondsuit}(t), \mu_{*\dagger}(t) = a_2 + b_2 \exp(c_2 t), \mu_{\diamondsuit\dagger}(t) = \mu_{*\dagger}(t),$$

where $a_1 = 4 \cdot 10^{-4}, b_1 = 3.4674 \cdot 10^{-6}, c_1 = 0.138155$ and $a_2 = 5 \cdot 10^{-4}, b_2 = 7.5858 \cdot 10^{-5}, c_2 = 0.087498$.

Calculate the (constant) annual premiums P for this policy.

Problem 3 Again let us have a look at a disability income insurance with term two years issued to a healthy life aged 50. Premiums are paid continuously throughout the contract period while the policyholder is in the healthy state. Disability benefits are provided at the rate of 60000$ per year.

Assume that the following transition probabilities are applied to the insured:

$$\begin{aligned} p_{**}(50, 50+t) &= \frac{2}{3} \exp(-0.015t) + \frac{1}{3} \exp(-0.01t), \\ p_{*\dagger}(50, 50+t) &= 1 - \exp(-0.01t). \end{aligned}$$

Use an intensity rate of 5% to compute the annual premiums P.