## QUESTION 1

For a multisate model with three states, Healthy (0), Disabled (1) and Death (2):

- For k=0 and 1

$$p_{x+k}^{00} = 0.60$$

$$p_{x+k}^{01} = 0.15$$

$$p_{x+k}^{10} = 0.10$$

$$p_{x+k}^{12} = 0.20$$

- There are 100 healthy lives, and future states are independent.

Calculate the variance of the number of the original 100 lives who die within the first two years.

- ◯ 19.3
- ◯ 22.8
- ◯ 24.5
- ◯ 17.2
- ◯ 28.6

## QUESTION 2

An insurance company classifies its auto drivers as Preferred (1) or Standard (2) at time 0. After issue, the driver is continously reclassified. For a driver, Bob, you are given:

- (x) denotes Bob's age at time 0.
- For k=0,1,2,...

$$p_{x+k}^{11} = 0.6 + \frac{0.1}{k+1}$$

$$p_{x+k}^{12} = 0.4 - \frac{0.1}{k+1}$$

$$p_{x+k}^{21} = 0.3 - \frac{0.2}{k+1}$$

$$p_{x+k}^{22} = 0.7 + \frac{0.2}{k+1}$$

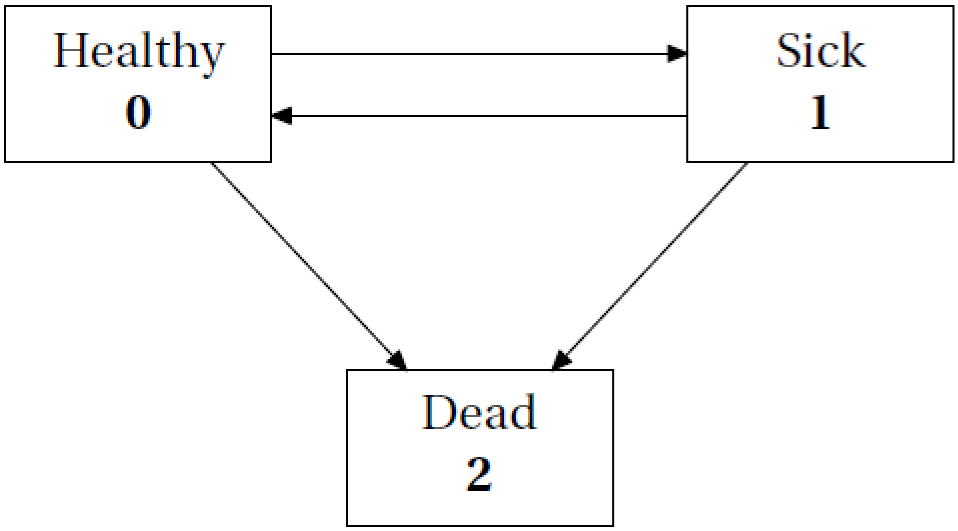
- Bob is classified as Preferred at the start of year 2.

Calculate the probability that Bob is classiffied as Preferred at the start of year 4.

- ◯ 0.49
- ◯ 0.63
- ◯ 0.44
- ◯ 0.55
- ◯ 0.41

## QUESTION 3

You are given the following Markov Chain:




| xy | 01 | 02 | 10 | 12 |
|---|---|---|---|---|
| ${}_2p_0^{xy}$ | 0.2 | 0.08 | 0.11 | 0.09 |
| $\mu_2^{xy}$ | 0.06 | 0.014 | 0.04 | 0.02 |

Calculate $\frac{d}{dt}\,{}_tp_0^{00}$ at t=2.

- -0.0434
- -0.461
- -0.0453
- -0.0446
- -0.479

**QUESTION 4**

Permanent disability is modeled as a Markov chain with three states: healthy (state 0), disabled (state 1), and dead (state 2). You are given the following transition forces:

$$\mu_{x+t}^{01} = \begin{cases} 0.05 & t \leq 5 \\ 0.1 & t > 5 \end{cases}$$

$$\mu_{x+t}^{02} = 0.04$$

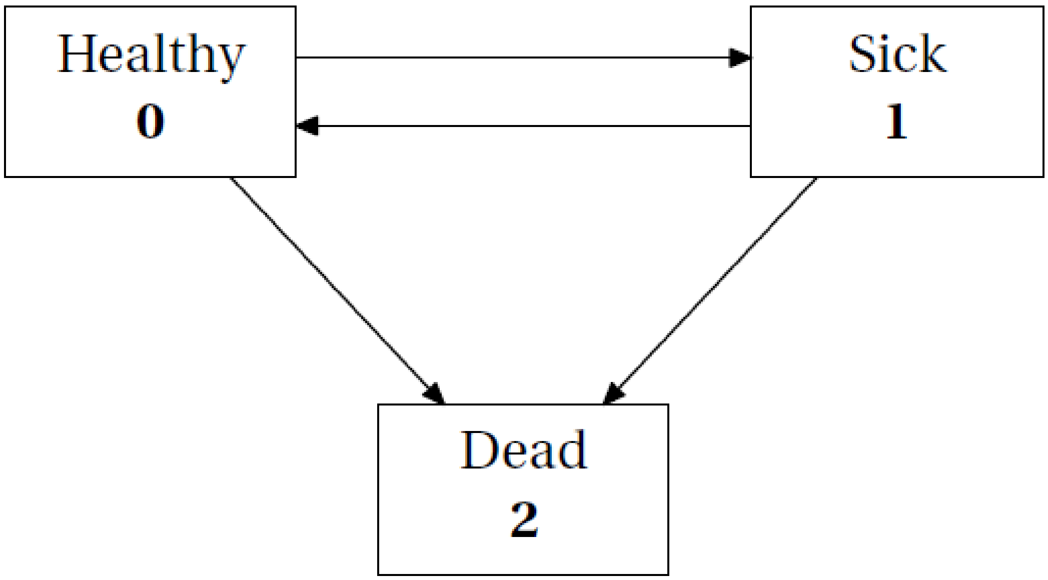
$$\mu_{x+t}^{12} = 0.04$$

Calculate the probability that a healthy person age x will be dead at age x + 10.

- ○ 0.18
- ○ 0.33
- ○ 0.44
- ○ 0.25
- ○ 0.27

**QUESTION 5**

A 20-year disability income policy on (x) is modeled with the following Markov chain:




You are given:

- Transition forces $\mu_{x+10}^{01} = 0.1, \mu_{x+10}^{01} = 0.4, \mu_{x+10}^{10} = 0.08, \mu_{x+10}^{12} = 0.05.$
- $\mu_{x+9.5}^{ij} = \mu_{x+10}^{ij}$ for all i and j.
- $\delta = 0.08$
- The policy pays a continuous annuity benefit of 1200 per year while sick and a death benefit of 20,000 at the moment of death.
- Continuous premiums for the policy are 200 per year, paid only when healthy
- ${}_{10}V^{(0)} = 2000, {}_{10}V^{(1)} = 10{,}000$

Calculate ${}_{9}V^{(1)}$ using Euler's method with step 0.5 to numerically solve Thiele's differential equation.

- 11904
- 10270
- 10688
- 11090
- 10553

## QUESTION 6

You are given the following Markov chain representing a three-stage disease:


You are given:

- The forces of transition are $\mu_{x+t}^{01} = 0.03, \mu_{x+t}^{12} = 0.15, \mu_{x+t}^{23} = 0.03$
- $\delta = 0.05$

A continuous annuity on (x) pays at a rate of 1 per year while the policyholder is in state 2.
Calculate the net single premium for this annuity for a healthy policyholder.

- ○ 2.87
- ○ 3.52
- ○ 2.55
- ○ 1.63
- ○ 3.01

## QUESTION 7

For a double decrement model you are given the following:

$$q_x^{(2)} = \frac{1}{8}$$

$$_{1|}q_x^{(1)} = \frac{11}{60}$$

$$q_{x+1}^{(1)} = \frac{1}{3}$$

Calculate $q_x^{(1)}$

- 0.3250
- 0.2725
- 0.2525
- 0.3550
- 0.1875

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## QUESTION 8

In a double-decrement table, you are given:

| x | $q_x^{(1)}$ | $q_x^{(2)}$ | $l_x^{\tau}$ |
|---|---|---|---|
| 25 | 0.01 | 0.15 | |
| 26 | 0.01 | 0.10 | 16800 |

Calculate the effect on $d_{26}^{(1)}$ if $q_{25}^{(2)}$ changes from 0.15 to 0.25.

- increase by 20
- decrease by 10
- increase by 10
- decrease by 20
- increase by 15