

Math 402 HW 11 Spring 2023. Due Monday, May 1. Final: Friday, May 12, 10:15-12:15

1) In a double decrement table, suppose  $q_{50}^{(1)} = 0.02$ ,  $q_{50}^{(2)} = 0.1$ , and each decrement satisfies the UDD assumption. Calculate  $q_{50}^{(2)}$ .

Hint: See Exam 3 review (200) 183) ii) with  $t = 1$ .

2) Find the 20th percentile premium  $\pi$  if  $\delta = 0.01$  and  $T_x \sim U(0, 50)$ .

Hint: See Exam 3 review 204) and 205).

3) Suppose the universal life insurance account value is updated monthly with interest per month  $i_m = 0.0025$  (so  $i^{(12)} = 0.03$ ). Let the annual premium be  $G=5000$ , assess expense charges at 50% of premium plus 10 per month and estimate monthly mortality rates at 1/12 per month (UDD). Then the monthly COI changes are  $COI = COI_t = \frac{100000(0.00076)}{(12)(1.0025)} = 6.32$ . Then  $AV_1 = [G(0.5) - 10 - COI](1 + i_m)$  and  $AV_t = [AV_{t-1} - 10 - COI](1 + i_m)$  for  $t = 2, 3$ . Compute  $AV_t$  for  $t = 1, 2, 3$ .

4) Consider a newly hired employee age 30, earning 100000 in the first year of employment. Regular salary increases are 4% a year, in addition, employees receive merit increase of 6% at each of their first three employment anniversaries. The pension benefit formula is 1% of the final five year average salary per year of service. Hence  $CAS_{30} = 100000$  and the salary scale factor is  $S_x = (1.04)^{x-30}(1.06)^3$  for  $x \geq 33$  with  $S_{30} = 1$ . The final five year average salary at retirement age 65 is

$$FAS_{65} = \frac{1}{5} \left( \frac{S_{60} + S_{61} + S_{62} + S_{63} + S_{64}}{S_{30}} \right) = 418458.46.$$

a) Find the projected annual benefit =  $0.01(FAS_{65})(35)$  where 35 = years of service when the employee retires at 65.

b) Find the employee's replacement ratio = pension benefit/final year salary where the (projected) final year salary is  $100000(1.06)^3(1.04)^{34}$ .