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Assignment

Q. 1)

(i) Constant force of mortality is an assumption to model fractional ages. It says the force of mortality between the age x & $x+1$ is (~~constant~~) constant.

(ii) Under CFM.

$$p_x = e^{-\mu_x}$$

$$\therefore \mu = -\ln(p_x)$$

$$\mu_{55} = -\ln(1-q_{55})$$

$$\mu_{55} = 0.00470\,10\,3255$$

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Q. 2)

(i) A select mortality is death rate of individual who have recently undergone some medical test. It is generally lower mortality rates as individual has passed ~~(...)~~ certain medical test.

(ii)

$$ {}_{20}p_{[25]:[30]} = {}_{20}p_{[25]} \times {}_{20}p_{[30]} $$

$$ = \frac{l_{45}}{l_{[25]}} \times \frac{l_{50}}{l_{[30]}} $$

$$ = \frac{9801.3123}{9951.9913} \times \frac{9712.0728}{9923.7497} $$

$$ = 0.9638520314 $$

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Q.3) UDD.

$${}_{1.4}q_{54.5} = 1 - {}_{1.4}p_{54.5}$$

$$= 1 - {}_{0.5}p_{54.5} \times {}_{0.9}p_{55}$$

$$= 1 - \left[\left(1 - {}_{0.5}q_{54.5}\right)\left(1 - {}_{0.9}q_{55}\right)\right]$$

$$= 1 - \left[\left(1 - \frac{0.5 \times q_{54}}{1 - 0.5 q_{54}}\right)\left(1 - 0.9\, q_{55}\right)\right]$$

$$= 1 - \left[\left(1 - \frac{0.5 \times 0.00714}{1 - 0.5 \times 0.00714}\right)\left(1 - 0.9 \times 0.00797\right)\right]$$

$$= 0.0107300 9121$$

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Q.4)

$$P\ddot{a}_{35:\overline{30|}} = 5000000\,A'_{35:\overline{30|}} + 30P\,A'_{35:\overline{30|}}$$

$$\ddot{a}_{35:\overline{30|}} = 14.35$$ [from tables]

$$A'_{35:\overline{30|}} = A_{35} - v^{30}\,{}_{30}p_{35}\,A_{65}$$

$$= 0.09488 - A \times 0.40177 = 0.08251$$ (B)

$$A_{35:\overline{30|}} = v^{30}\,{}_{30}p_{35}$$

$$= (1.05)^{-30}\left(\frac{8821.2612}{9894.4299}\right)$$

$= 0.15522581\,97$ (A)

$$\therefore\ P(14.35 - 30 \times A) = 5000000 \times B$$

$$P = 16771.98381$$

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Q. 5)

(i) $\bar{a}_x$

(ii) $\cancel{\bar{a}_x = \int_0^\infty v^s \, {}_sp_x \, ds}$

$PV = \bar{a}_{\overline{T_x}|}$, $T_x > 0$

$EPV = \bar{a}_x = \int_0^\infty v^s \, {}_sp_x \, ds$

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Q. 6)

(i) $P = 5{,}000000\, A^{1}_{45:\overline{20|}}$

$A^{1}_{45:\overline{20|}} = A_{45:\overline{20|}} - A_{45:\overline{20|}}^{\ \ 1}$

$= 0.46998 - (1.04)^{-20}\left(\frac{8821.2612}{9801.3123}\right)$

$= 0.0592280172c.$

$P = 296140.0863.$

$\therefore$ Total single premium $= 10000 \times P$

$= 2961400863$

(ii) $V = 5000000\, A^{1}_{46:\overline{19|}} - 296140.0863$

$= 5000000\left[0.34599 - (1.06)^{-19}\left(\frac{8821.2612}{9786.9534}\right)\right]$

$- 296140.0863$

$= -55694.26417.$

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$DSAR = 5000000 - (-55694.26417)$

$= 5055694.26417.$

$EDS = 10000 \; q_{45} \times DSAR$

$= 74065920.97$

$ADS = 10 \times DSAR$

$= 50556942.6417.$

~~Mortal~~ MP $= EDS - ADS$

$= 23508978.33$

Q7)

$EPV = 100000 \hat{A}_{40:\overline{20|}} + 200000 v^{20} {}_{20}p_{40} A_{60}$

$= 100000 \left(A_{40} - v^{20} {}_{20}p_{40} A_{60} \right) + 200000 v^{20} {}_{20}p_{40} A_{60}$

$v^{20} {}_{20}p_{40} = (1.06)^{-20} \left(\frac{9287.2164}{9856.2863} \right)$

$= 0.2938021365$ (A)

$A_{40} = \cancel{0.23056}$ 0.12313.

$\cancel{EPV}$ $A_{60} = \cancel{0.45640}$ 0.32192

$EPV = \cancel{36465.12951}$ 21917.97945

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$$E(PV^2) = 100000^2 \left({}^2A^1_{40:\overline{20}|} \right) + 200000^2 \; {}^2A_{60} \; v^{20} \; {}_{20}p_{40}$$

$$ {}^2A^1_{40:\overline{20}|} = {}^2A_{40} - v^{40} \; {}_{20}p_{40} \; {}^2A_{60}$$

$$= \cancel{0.06792}\ 0.02707 - (1.06)^{-40} \left(\cancel{0.14098} \right) (0.14098) \left(\frac{9287.2164}{9856.288} \right)$$

$$= 0.01415.$$

$$E(PV^2) = 179835878 8$$

$$SD = \sqrt{E(PV^2) - [E(PV)]^2}$$

$$= 36303.73211$$

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Q.8. $A_{65} = 0.5412$

$A_{66} = 0.5591$

$A_{65} = q_{65} + (1-q_{65}) A_{66} v$

$A_{65} = q_{65} + A_{66} v - A_{66} v q_{65}$

$A_{65} - A_{66} v = q_{65} (1 - A_{66} v)$

$$\frac{0.5412 - 0.5591(1+0.05)^{-1}}{1 - 0.5591(1.05)^{-1}} = q_{65}$$

$q_{65} = 0.0487564$

$A_{[65]} = 0.75 q_{65} + \frac{(1 - 0.75 q_{65}) 0.5591}{1.05}$

$A_{[65]} = 0.535321.$

$P = 100000 \times 0.535321$

$P = 53532.12963.$

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Q.9) (i) $P = 120\,000\, a_{70}$

$P = 120000\,(\ddot{a}_{70} - 1)$

$= 120000\,(10.562)$

$P = 1267440.$

(ii) $P(L_0 > 0) = 1$

$P(L_0 \le 0 \mid G = G_{\pi}) = P(K_{70} \ge n)$

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10)

(i) $PV = \bar{a}_{\overline{T_x}|}$

$$EPV = \int_0^\infty \bar{a}_{\overline{t}|} \cdot {}_tp_x \cdot \mu_{x+t} \, dt = \bar{a}_x$$

(ii) we know..

$$\int_0^\infty e^{-(\mu+\delta)t} \, dt = 16$$

$$= \frac{1}{-(\mu+0.04)} \left[e^{-(\mu+\delta)t} \right]_0^\infty = 16$$

$$= \frac{-1}{(\mu+0.04)} \left[0 - 1 \right] = 16$$

$$1 = 16\mu + 0.64$$

$$\mu = \frac{1-0.64}{16}$$

$$\mu = 0.0225$$

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$$Var = \frac{1}{\delta^2}\left({}^2\bar{A}_x - (\bar{A}_x)^2\right)$$

$$\bar{A}_x = 1 - \delta\,\bar{a}_x$$

$$\bar{A}_x = 1 - 0.64$$
$$= 0.36$$

$${}^2\bar{A}_x = \int_0^\infty e^{-2\delta t}\, e^{-\mu t} \times \mu \; dt$$

$$= 0.0225\left[\frac{e^{-(2\delta+\mu)t}}{-(2\delta+\mu)}\right]_0^\infty$$

$$= \frac{-0.0225}{(2\times0.0225+0.04)}\left[0-1\right]$$

$$= \frac{9}{34}$$

$$SD = \sqrt{\frac{1}{0.04^2}\left(\frac{9}{34} - (0.36)^2\right)}$$

$$= 9.18918602$$

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Q11)

(i) In term assurance the premiums are paid annually in advance for the term where if a policy holder fails to pay premium he or she will no longer be in the force with the contract where as the annuity contract is a single premium contract, the policy holder ~~had~~ would have paid the premium at the start and is in to force till he/she dies.

(ii) Term Assurance

$$P\ddot{a}_{40:\overline{25}|} = 2{,}500{,}000\, A^{1}_{40:\overline{25}|}$$

$$A^{1}_{40:\overline{25}|} = A_{40:\overline{25}|} - A_{40:\overline{25}|}^{\ \ 1}$$

$$= 0.38907 - (1.04)^{-25}\left(\frac{8821.2612}{9856.2863}\right)$$

$$= 0.0533448501 9 \quad (A)$$

$$P = \frac{2800000 \times A}{15.884}$$

$$P = 8396.002296 \quad (B)$$

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$_{10}V = 2500000 A^{1}_{50:\overline{15|}} - P \ddot{a}_{50:\overline{15|}}$

$A^{1}_{50:\overline{15|}} = A_{50:\overline{15|}} - A_{50:\overline{15|}}^{\ \ 1}$

$= 0.56719 - (1.04)^{-15} \left(\frac{8821.2612}{9712.0728} \right)$

$= 0.062885$

$_{10}V = 87334.42964 \quad (M)$

Annuity.

$_{10}V = 250000\ \ddot{a}_{60}$

$= \cancel{3533350} \quad (Y)$

3908000

Total portfolio reserve = $8500 \times M + 9900 \times Y$

$= \cancel{35123992650}$

39431542150

(iii) Premiums of term Assurance.

Investments in different ~~so~~ securities.

Q12

(i) $s_{55:\overline{10|}} = a_{55:\overline{10|}} (1+i)^{10} \; {}_{10}p'_{55}$

$= \left(\dfrac{8821.2612}{9557.8179}\right)(1.06)^{10} \times 7.461$

$= 12.57810568$

(ii) $\ddot{a}^{(4)}_{[40]:\overline{20|}} = \ddot{a}^{(4)}_{[40]} - v^{20} \; {}_{20}p_{[40]} \; \ddot{a}^{(4)}_{60}$

$= \ddot{a}_{[40]} - \dfrac{3}{8} - v^{20} \; {}_{20}p_{[40]} \left(\ddot{a}_{60} - \dfrac{3}{8}\right)$

$= \left(15.494 - \dfrac{3}{8}\right) - (1.06)^{-20} \left(11.891 - \dfrac{3}{8}\right) \left(\dfrac{9287.2164}{9854.3036}\right)$

$= 14.67350635$

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Q. 13

(c) $P\ddot{a}_{45:\overline{15}|} = 100,000\, A_{45:\overline{20}|} + 100,000\, A^{\;\;1}_{45:\overline{20}|}$

$\ddot{a}_{45:\overline{15}|} = 11.886$

$A_{45:\overline{20}|} = 0.46991$

$A^{\;\;1}_{45:\overline{20}|} = (1.09)^{-20}\ {}_{20}P_{45}$

$= 0.410751982 7$

$P = 7734.603748$

(d) ${}_{13}V = 100000\, A_{58:\overline{7}|} + 100000\, A^{\;\;1}_{58:\overline{7}|} - P\ddot{a}_{58:\overline{2}|}$

$A_{58:\overline{7}|} = 0.76516$

$A^{\;\;1}_{58:\overline{7}|} = (1.04)^{-7} \times {}_{7}P_{58}$

$= 0.712885$

$\ddot{a}_{58:\overline{2}|} = 1.955$

${}_{13}V = 132603.4289$

$DSAR = 100000 - \frac{1}{3}V$

$= -32603.42895$

$RDS = 199 \times 0.00565 \times DSAR$

$= -36657.66534$

$ADS = 4 \times DSAR$

$= -130413.7158$

$M.P = RDS - ADS$

$= 93756.05046$

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Q.4)

(i)

$$5000\ \bar{a}_{\overline{T_{63}-2|}}\ v^2 \quad ; \quad T_{63} \le 2$$
$$; \quad T_{63} > 2$$

(ii)

$$5000 \times 100 \times {}_2p_{63} \times v^2\ \bar{a}_{65}$$

$$= 500000\ (14.871 - 0.5)\ (1.04)^{-2} \left(\frac{9703.708}{9775.888}\right)$$

$$= 6594347.317$$

(iii) $E(x^2) = \cancel{5000^2 \times 100 \times v^4 \times {}_2p_{63}\ (}$

$$Var = 5000^2 \times 100 \times \cancel{x}$$
$$\frac{1}{\delta^2}\left(v^{2n}\ {}_nq_x + \delta^2\ v^{2n}\ {}_np_2\ {}^2\bar{A}_{x+n} - \left(v^n\ {}_nq_x + v^n\ {}_np_x\ (\bar{A}_{x+n})^2\right)\right]$$

$$\cancel{A_x} = 5000^2 \times 100 \times \frac{1}{\delta^2}\left(v^{2\times 2}\ {}_2q_{63} + v^{2\times 2}\ {}_2p_{63}\ {}^2\bar{A}_{65} - \left(v^2\ {}_2q_{63} + v^2\ {}_2p_{63}\ (\bar{A}_{65})^2\right)^2\right]$$

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$$\bar{A}_{65} = 1 - \delta\, \bar{a}_{65}$$

$$\bar{A}_{65} = 0.436359 \quad (B)$$

$$^2\bar{A}_{65} = \cancel{\text{tos}}\ (1.04)^{0.5}\ (0.20847)$$

$$= 0.2125985 \quad (C)$$

$$\cancel{2t_{63}}\ {}_2p_{63} = \frac{9703.708}{9775.888}$$

$$= 0.9926 \quad (D)$$

$$_2q_{63} = 1 - D$$

$$= 0.007383 \quad (E)$$

$$\text{Var} = 5000^2 \times 100 \times 13.53$$

$$= (183937.6604)^2$$

Q15)

a $$({}_tV + P)(1+i) - x(1+i)^{11/12} - x(1+i)^{10/12} - S\,q_{x+t} = {}_{t+1}V\,p_{x+t}$$

b $$({}_tV + P)(1+i) - S\,q_{x+t} - R\;{}_{0.5}p_{x+t} = \cancel{{}_{t+1}V\,p_{x+t}}$$

$$= {}_{t+1}V \times p_{x+t}$$