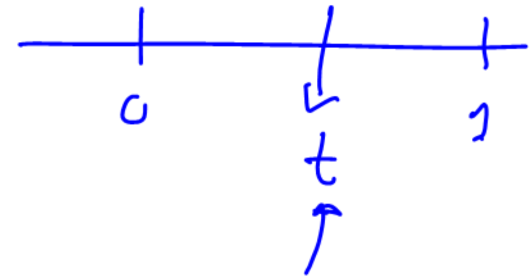
① $q^{\;\;1}_{50:55:60}$

$q_{50} \cdot p_{55}\; p_{60}$



$$\int_0^1 {}_tp_{50}\,\mu_{50+t} \cdot {}_tp_{55}\; {}_tp_{60}\; dt$$

UDD

${}_tq_x = t \cdot q_x$

${}_tp_x = 1 - t \cdot q_x$

$$= \int_0^1 q_{50}\,(1 - t\,q_{55})(1 - t\,q_{60})\,dt$$

$$= q_{50} * \left(t - \frac{t^2}{2}(q_{55} + q_{60}) + \frac{t^3}{3} q_{55} q_{60} \right)\Bigg|_0^1$$

$$= \frac{5.92}{1000} * \left(1 - \frac{1}{2}\left(\frac{8.96 + 13.76}{1000} \right) + \frac{1}{3}\left(\frac{8.96}{1000}\right)\left(\frac{13.76}{1000}\right) \right)$$

$$= .00585$$

whole life to (40) of 1

$$P = \frac{A_{40}}{\ddot{a}_{40}} = \frac{.16132}{14.8166} = .0108779$$

P^*

discrete -

Loss at issue $= PVFB_0 - PVFP_0$

$$L_0 = v^{K+1} - \frac{P^*}{d}\underbrace{(1-v^{K+1})}_{\ddot{a}_{\overline{K+1|}}}$$

$$= v^{K+1}\left(1+\frac{P^*}{d}\right) - \frac{P^*}{d} > 0 \Rightarrow$$

$$v^{K+1} > \frac{P^*/d}{(1+P^*/d)}$$

$$(\log v)(K+1) > \log \cdots$$

$$\underbrace{K < -1 + \frac{1}{\log v}\left(\log \frac{P^*/d}{1+P^*/d}\right)}_{m}$$

$P[L_0 > 0] < 0.5$

$= \cancel{\log} v$

$i = 6\%$

$\log\left(\frac{1}{1.06}\right)$

$$\underbrace{Pr(L_0 > 0) = Pr(K < m)} \leq 0.50$$

$$m = -1 + \frac{1}{\log v}\left(\log \frac{p^*/a}{1+p^*/a}\right)$$

$$\underbrace{Pr(K \geq m)} \geq 0.50$$

$$_mp_{40} \geq 0.50$$

$$\frac{l_{40+m}}{l_{40}} \geq 0.5$$

$$l_{40+m} \geq \frac{1}{2} l_{40} = 4{,}656{,}583$$

9313166

$$l_{77} = 4828182$$

$$l_{78} = 4530360$$

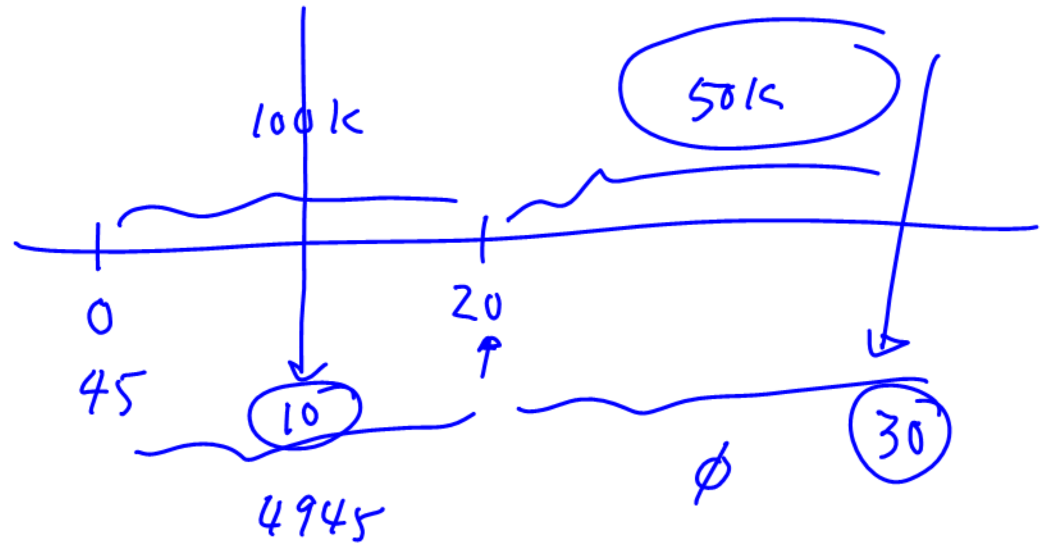
$m \geq 38$ years

$$p^* \geq .00650359 \Rightarrow \frac{p}{p^*} = \underline{1.674128}$$

Special whole life

$${}_{10}V^{n} = APVFB_{10} - APVFP_{10}$$

$$\cancel{+APVFE_0}$$



$$= \left(100{,}000\, A_{55} - 50{,}000\, A_{65} \cdot {}_{10}E_{55}\right)$$

$$- \left(4945\, \ddot{a}_{55} - 4945\, \ddot{a}_{65} \cdot {}_{10}E_{55}\right)$$

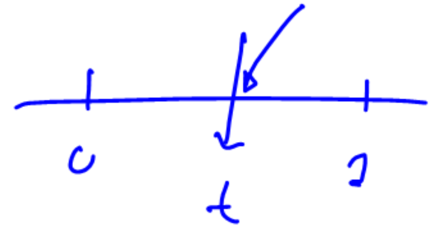
$$= \underline{\underline{30{,}661.93}}$$

$${}_{30}V = APVFB_{30} - \cancel{APVFP_{30}}^{\to 0} = \boxed{50000\, A_{75}}$$

$q'^{(1)}_x = .1$, $q'^{(2)}_x = .2$,

UDD $\rightarrow$ q' SDT, q MDT

$$q^{(1)}_x = ?$$



$$q^{(1)}_x = \int_0^1 {}_tp^{(\tau)}_x \, \mu^{(1)}_{x+t} \, dt$$

$$\mu'^{(1)}_{x+t} \, dt$$

$$q^{(2)}_x =$$

$${}_tp^{(\tau)}_x = e^{-\int_0^t \mu^{(\tau)}_{x+s} \, ds} \qquad \mu'^{(1)}_{x+s} + \mu'^{(2)}_{x+s}$$

$$= {}_tp'^{(1)}_x \, {}_tp'^{(2)}_x$$

$$= \int_0^1 \underbrace{{}_tp'^{(1)}_x \, \mu'^{(1)}_{x+t}} \; \underbrace{{}_tp'^{(2)}_x} \, dt$$

$$\int_0^1 q'^{(1)}_x \left(1 - t \cdot q'^{(2)}_x\right) dt$$

$$= \int_0^1 q'^{(2)}_x \left(1 - t \cdot q'^{(1)}_x\right) dt$$

$$= q'^{(2)}_x \left(1 - \tfrac{1}{2}(.1)\right) = .95 \, q'^{(2)}_x = .2 \Rightarrow q'^{(2)}_x = 0.2/0.95$$

Fall 2014

$$q_x'^{(1)} = .1\ , \quad q_x'^{(2)} = \frac{.2}{.95} = .2105263$$

$$p_x'^{(1)}\, p_x'^{(2)} = (1-.1)(1-.2105263) = .7105263 = p_x^{(\tau)}$$

$$q_x^{(1)} = ?\ , \quad q_x^{(2)} = 0.2$$

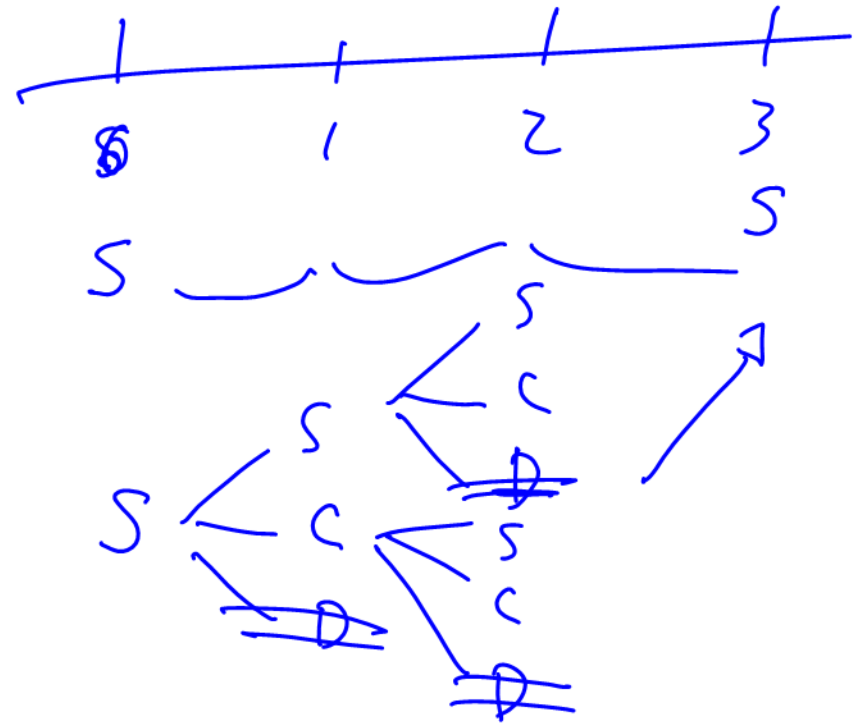
$$q_x^{(1)} + \underset{.2}{q_x^{(2)}} = q_x^{(\tau)} = 1 - p_x^{(\tau)} = \underline{1 - .7105263}$$

SDT $\leftrightarrow$ MDT

QH5 ✓ S C D

discrete

Q^3 1



$S \to S \to S \to S$ $(.6)^3 = .216$

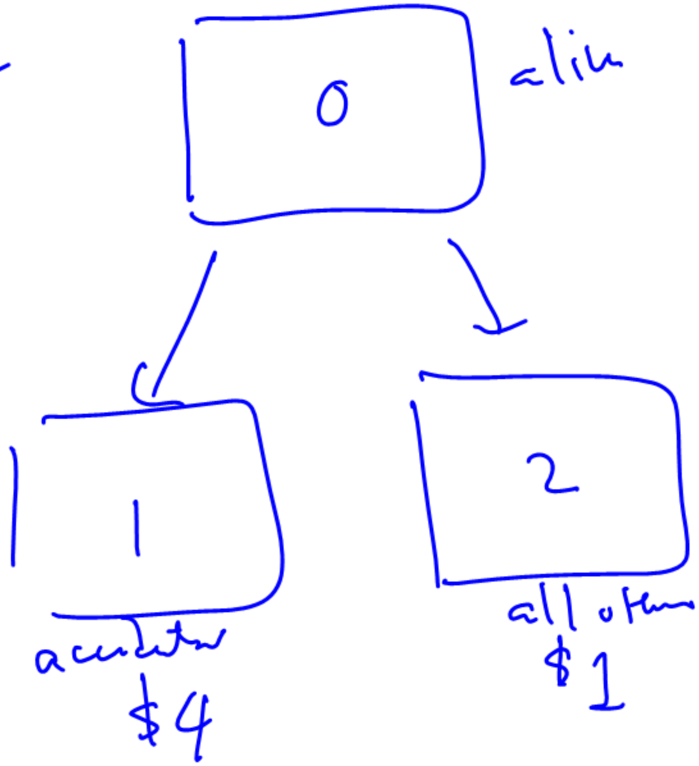
$S \to S \to C \to S$ $(.6)(.2)(.1) = .012$

$S \to C \to S \to S$ $(.2)(.1)(.6) = .012$

$S \to C \to C \to S$ $(.2)(.5)(.1) = .010$ +

.250 ✓

Q#3



(x)

continuous

$\delta = .04$

$$ {}_tp_x^{00} = {}_tp_x^{\overline{00}} = e^{-\int_0^t .015\, ds} = e^{-.015t} $$

$$ APV(\text{benefits}) = 4\int_0^\infty e^{-\delta t} \cdot {}_tp_x^{00}\, \mu_{x+t}^{01}\, dt + 1 \cdot \int_0^\infty e^{-\delta t} \cdot {}_tp_x^{00}\, \mu_{x+t}^{02}\, dt $$

$$ = 4(.005)\underbrace{\int_0^\infty e^{-.055t}\, dt}_{1/.055} + 1(.010)\underbrace{\int_0^\infty e^{-.055t}\, dt}_{1/.055} $$

$$ = .5454545 $$

Q #7

$DB = \underbrace{10{,}000}_{\Downarrow \text{ Additional is fixed}} + AV$

$AV_5 = 11196.12$

Corridor Factor $\geq \underline{\underline{1.5}}$

$$\frac{AV + DB}{AV}$$

0 — 5 — 6

57 — AV_5

π_5 = premium at b.o.y.

$$AV_6 = \left(\underset{\downarrow\, 11196.12}{AV_5} + \pi_5 \overbrace{(1-.025)}^{.975}\right)(1.05) - \underbrace{1.5\, \underset{\downarrow\, .002}{q_{55}}\,(10000)}_{30}$$

$~~11728.95~~$

$$= \cancel{11728.95}\ 11725.93 + 1.02375\,\pi_5 \leq 20{,}000$$

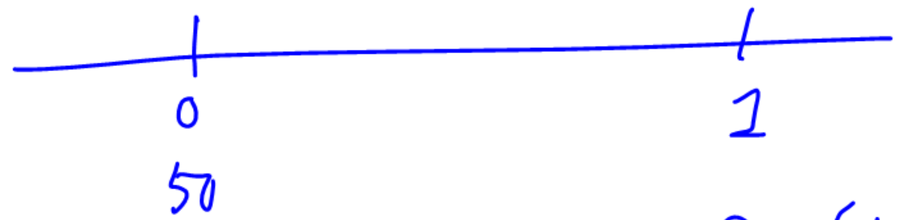
$$\frac{AV_6 + 10{,}000}{AV_6} \geq 1.5 \Rightarrow AV_6 \leq 20{,}000$$

$\Downarrow$

$\pi_5 \leq 8082.12$

Q#8   Type A   Total DB $= 100{,}000$

COI   120% ILT



(a) COI in year 1

$$AV_1 = \left(0 + \pi_0(1-f) - e - COI\right)(1+i^c)$$

$$COI \rightarrow \frac{1.20\, q_{50}\,(100{,}000 - AV_1)}{1+i^g}$$

$$AV_1 = \left(15{,}000(1-.01)\right)(1.05) - \frac{1.20}{1.04}\left(\frac{5.92}{1000}\right)(100{,}000 - AV_1)(1.05)$$

$$\Rightarrow AV_1 = \frac{14875.27}{0.9928277} = \underline{14982.73}$$

$$COI = \frac{1.2\left(\frac{5.92}{1000}\right)(100{,}000 - 14982.73)}{1.04} = 580.7334$$

(b)

$$\frac{AV_1 + \text{Add'l DB}}{AV_1} \geq \cancel{14}\ 2.2 \Rightarrow \frac{100{,}000}{\cancel{AV_1}} \leq 2.2\, AV_1$$

$$AV_1 \geq \frac{100{,}000}{2.2}$$

$$100{,}000 - AV_1 = 100{,}000 - \frac{100{,}000}{2.2}$$

$$\frac{AV_1 + \text{Add'l DB}}{AV_1} \geq 2.2 \Rightarrow \text{Total DB} \leq 2.2\, AV_1$$

$$AV_1 = 15000(.99)(1.05) - \frac{1.2\ \overset{5.92}{\cancel{950}}}{1.04}\left(\underbrace{2.2\,AV_1 - AV_1}_{1.2\,AV_1}\right)(1.05)$$

$$AV_1 = \frac{15592.5}{1.008607} = 15{,}459.44$$

$$COI = \frac{1.2\, q_{50}}{1.04} \times \underbrace{1.2\, AV_1}_{15459.44} = \underline{\underline{126.7199}}$$

(c) COI = larger of the two $= \max(126.7199,\ 580.7334)$

$$= 580.7334$$

Q#9 Type B

ADB = 200,000

AV 45000 49,480

0 8 9

55

5000

~~35%~~, 10%

$i^c = i^g$

49480 45000

$$AV_9 = \left(AV_8 + 5000(1-.10)\right)(1+i)$$

$q_{63} = .01$

$$- \frac{.01}{\cancel{1+i}}\left(200{,}000 + \cancel{AV_9} - \cancel{AV_9}\right)(\cancel{1+i})$$

$$\Rightarrow \quad i = \frac{49480 + 2000}{45000 + 5000(.9)} - 1 = 4\%$$

Q#10 Type A: 100,000

Type B: 100,000

monthly

100%

UDD

$\frac{i^{(12)}}{12} = .004$

Policy 1 a

$$AV_{37}^{a} = \left(AV_{36}^{a} + G - E\right)(1.004) - \frac{1}{12} q_{63}\left(100{,}000 - AV_{37}^{a}\right)$$

0 36 37

60 63

$$AV_{37}^{a}\left(1 - \frac{1}{12} q_{63}\right) = \left(AV_{36}^{a} + G - E\right)(1.004) - \frac{1}{12} q_{63}\, 100{,}000$$

Policy 2 b

$$AV_{37}^{b} = \left(AV_{36}^{b} + G - E\right)(1.004) - \frac{1}{12} q_{63}\, 100{,}000$$

$$\frac{AV_{37}^{a}\left(1 - \frac{1}{12} q_{63}\right)}{AV_{37}^{b}} = 1 \Rightarrow \frac{AV_{37}^{a}}{AV_{37}^{b}} = \frac{1}{1 - \frac{1}{12}\left(\frac{17.88}{1000}\right)} = \underline{1.001492}$$

Q#11

Total DB $= 10{,}000 + AV -$

$i^{(12)} = .048$

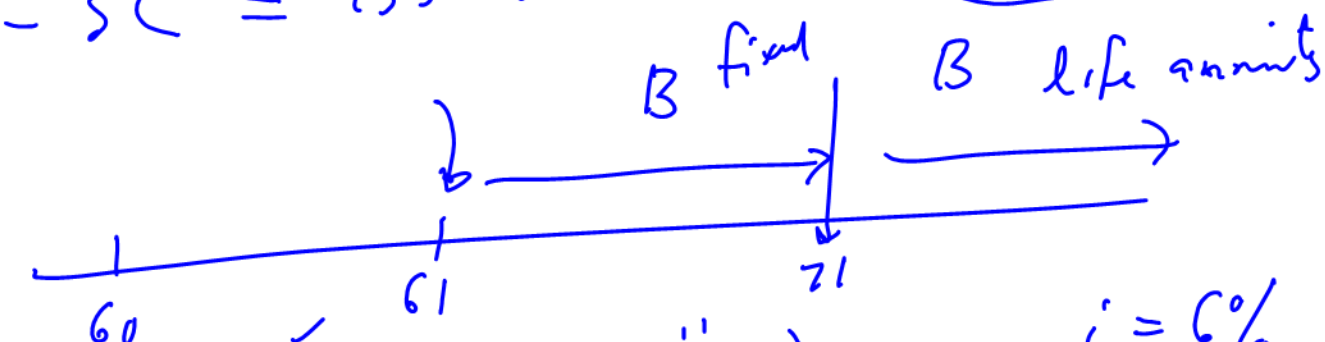
$\frac{i^{(12)}}{12} = \frac{.048}{12} = .004$

$$AV_{12} = \left(\frac{\overset{1500}{AV_{11}} + 100(1-.15) - 10 - \frac{3}{1000}\left(10{,}000 + \cancel{AV_{12}} - \cancel{AV_{12}}\right)}{1.004} \right)(1.004)$$

$400 = SC$

$= \underline{1551.3}$

$CV_{12} = AV_{12} - SC = 1551.3 - 400 = \underline{1151.3}$



$i = \underline{6\%}$

$$1151.3 = B\left(\ddot{a}_{\overline{10|}} + {}_{10}E_{61}\, \ddot{a}_{71}\right)$$

$$\ddot{a}_{\overline{10|}} = \frac{1-v^{10}}{d} = \frac{1-(1/1.06)^{10}}{.06/1.06} = 7.801692$$

$${}_{10}E_{61}\ \ddot{a}_{71} =$$

$$\underbrace{{}_{10}E_{61}}_{.44231}\ \underbrace{\ddot{a}_{71}}_{8.2988}$$

$$B = \frac{1151.3}{7.801692 + .44231(8.2988)} = 100.3545$$