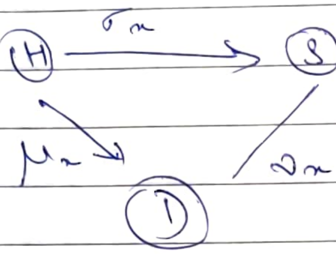
Q2) $x = 40$, $S = 100000$ immedi. on death or illness.



$i = 5\%$

$\mu_x = 0.004$

$\nu_x = 0.005$

$\sigma_x = 0.002$

$\delta = \ln(1+i)$

$\delta = 0.04879.$

EPV of critically illness.

$$= \int_0^{20} 100{,}000 \, e^{-\delta t} \times {}_tp_{40}^{HH} \times \sigma_{40+t} \, dt$$

$$= \int_0^{20} 100{,}000 \, e^{-0.04879t - 0.006t} \times 0.002 \, dt$$

$$= \int_0^{20} 100000 \times 0.002 \, e^{-0.05479t} \, dt$$

$$= 200 \left[\frac{-e^{-0.05479t}}{0.05497} \right]_0^{20}$$

$$= 200 \left[\frac{1 - e^{-0.05479 \times 20}}{0.05479} \right]$$

EPV of Death:

$$100000 \int_0^{20} e^{-\delta t} \times {}_tp_{40}^{HH} \times \mu_{40+t} \, dt.$$

$$= 400 \left[\frac{1 - e^{-0.05479 \times 20}}{0.05479} \right]$$

EPV of Benefits :-

$$200 + 400 \left[\frac{1 - e^{-0.05479 \times 20}}{0.05479 \times 2} \right]$$

$$= 7290.322$$

3) Premium :-

$P\ddot{a}^{(12)}_{40:\overline{20}|}$

$= P\left[\ddot{a}_{40:\overline{20}|} - \frac{11}{24}\left(1-\frac{D_{60}}{D_{40}}\right)\right]$

$= P\left[13.927 - \frac{11}{24}\left(1-\frac{882.85}{2052.96}\right)\right]$

$= 13.66576724\ P$

Claim cost.

$\cancel{7500}\ 7500000\ A^{1}_{40:\overline{20}|} + 50000\ A^{1}_{[40]:\overline{20}|}$

$7500000\left[A_{40:\overline{20}|} - \frac{D_{60}}{D_{40}}\right] + 50000\left[A_{[40]:\overline{20}|} - \frac{D_{60}}{D_{[40]}}\right]$

$= 257193.968202 + 170521.965824$

$= 427714.9651$

Commission expenses.

$0.3P\ddot{a}^{(12)}_{40:\overline{1}|} + 0.05P\ddot{a}^{(12)}_{40:\overline{20}|}$.

$0.3P\left[\ddot{a}_{40:\overline{1}|} - \frac{11}{24}\left(1-\frac{D_{41}}{D_{40}}\right)\right] + 0.05P\left[\ddot{a}_{40:\overline{20}|} - \frac{11}{24}\left(1-\frac{D_{60}}{D_{[40]}}\right)\right]$

$= \cancel{0.3P}\ 0.965067\ P$

Mag. cost.

$= 0.1P\ddot{a}^{(12)}_{40:\overline{20}|} \times 1.04^{0.5}$

$\cancel{0.1}\ 1.39364\ P$

Premium

$13.6657\ P =$

$P = 39009.7$

Accident clai

$7500000\ A^{1}_{45}$

$= 7500000 \times$

$= 269250$

$- 16536$

illness claim

$= 5000,000\ A$

$- 263766.$

No claim ma

$= 125000$

$- 14228$

Premium

$$13.6057P = 427714.9558 + 12831.44 + 0.966P + 1.393P + 500$$

$P = 39009.7$ // monthly $= 3250.8$

Accident claim.

$$7500000 A_{45:\overline{15|}} = 39009.7\, \ddot{a}^{(12)}_{45:\overline{15|}}$$

$= 7500000 \times 0.0359 - 39009.7 \times 11.1448$

$= 269250 - 434750.3046$

$= -165363.43774$

illness claim.

$= 5000000 A_{45:\overline{15|}} - 39009.7\, \ddot{a}^{(12)}_{45:\overline{15|}}$

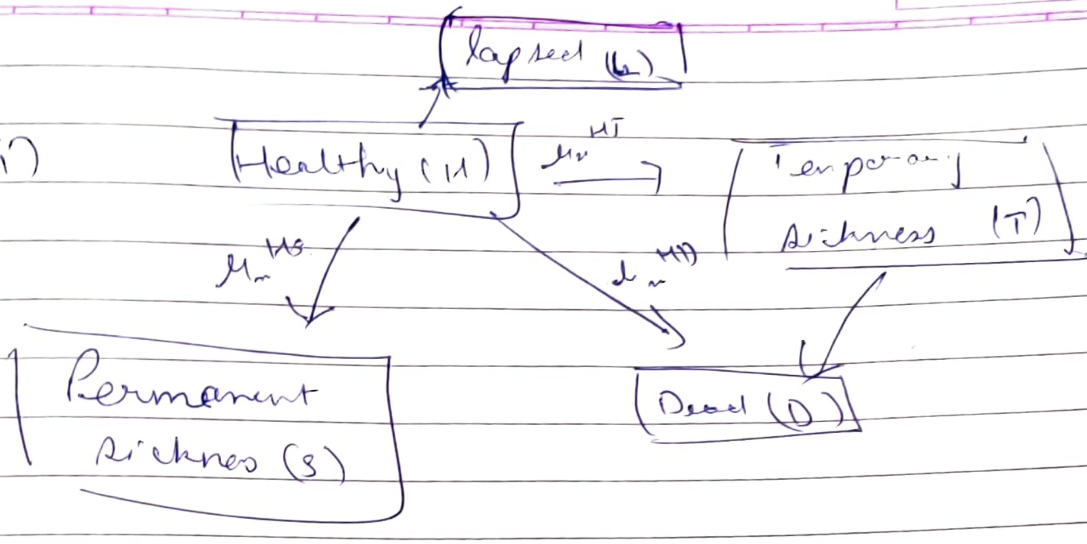
$= -263766.0049$

No claim made

$= 1250000 \times 0.035918 2 - 434750.6352$

$= 142286 \, 0273$

4) (i)



(ii) $x = 50$, $n = 15$

EPV (Premium) = EPV (Benefits)

$$EPV(T) = 10000 \int_0^{15} v^t \, {}_tp_{50}^{HT} \, dt$$

$$EPV(S) = 20000 \int_0^{15} v^t \, {}_tp_{50}^{HS} \, dt$$

$$EPV(\text{Death}) = 100000 \int_0^{15} v^t \left({}_tp_{50}^{HH} \mu_{50+t}^{HD} + {}_tp_{50}^{HT} \mu_{50+t}^{TD} + {}_tp_{50}^{HS} \mu_{50+t}^{SD} \right) dt$$

$$EPV(\text{Premium}) = P \int_0^{15} {}_tp_{50}^{HH} v^t \, dt$$

$$P = \frac{10000 \int_0^{15} v^t \, {}_tp_{50}^{HT} \, dt + 20000 \int_0^{15} v^t \, {}_tp_{50}^{HS} \, dt + 100000 \int_0^{15} v^t \mu \, dt}{\int_0^{15} {}_tp_{50}^{HH} v^t \, dt}$$

Page No.:
Date:

5(i) Gross premium for compound reversionary policy:

EPV premium :- $P\ddot{a}_{[40]:\overline{25}|}$

$= 15.887\,P$

EPV expenses :- $1200 + 500\bar{A}_{[40]} + 0.02P(\ddot{a}_{[40]:\overline{25}|} - 1)$

$= 1317.487 + 0.297P$

EPV of Benefits. $\frac{200000}{1.04^{0.5}}\left(q_{[40]} + (1.04)\,{}_{1|}q_{[40]} + \ldots\right)$

$= 196116.14$

$15.887P = 1317.487 + 0.29774P + 196116.14$

$P = 12664$

(ii). EPV (benefits) $= 200{,}000 \times b(\bar{I}\bar{A})_{[40]} + 200{,}000(1-b)\bar{A}_{[40]}$

$(1.04)^{0.5}\left[200{,}000 \times b(IA)_{[40]} + 200000(1-b)A_{[40]}\right]$

$= 196116.14$

$b = 9\%$

(iii) Net premium

$P\ddot{a}_{40:\overline{25}|} = 200{,}000\bar{A}_{40}$

$P = 2960.54$

NPR at $t = 10$

${}_{10}V = 300{,}000\bar{A}_{50} - P\ddot{a}_{50:\overline{15}|}$

$= 300000 \times 1.04^{0.5} \times 0.32907 - 2960.54 \times 11.253$

$= 67361.10$

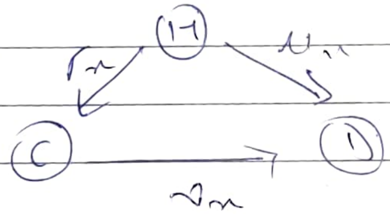
B) $n = 20$, $x = 45$; $P = 2$

$i = 5\%$

$DB \to SA = 100,000$ EOYOD $\qquad \delta = \ln(1+i)$

Cancer $= SA = 100,000$ EOY $\qquad = 0.04879$

Surrender $\to$ Premium



$\mu_x = 0.006$

$\sigma_x = 0.002$

$\nu_x = 0.01$

$IC = 0.02$, $IF = 0.02P$, Profit margin $= 10\%$

EVP of Benefits:

$$= 100000 \int_0^{20} e^{-\delta t} \, {}_tp_{45}^{HH} \left(\mu_{45+t} + \sigma_{45+t}\right) dt.$$

$$= 100000 \int_0^{20} e^{-0.04879} \, {}_tp_{45}^{HH} \, (0.008) \, dt.$$

$${}_tp_{45}^{HH} = e^{-0.008t}$$

$$= 100000 \int_0^{20} e^{-0.05679 t} \times 0.008 \, dt$$

$$= 800 \left[\frac{1 - e^{-0.05679 \times 20}}{0.05679} \right]$$

$$= 9562.7387.$$

EPV of premium return,

$$= P\, e^{-\int_{45}^{65} 0.008\, dx}\; v^{20}$$

$$= P\, e^{-0.16} \times 0.37689$$

$$= 0.321164P.$$

Premium = EPV (DB + Comm) + EPV (Return ~~of~~ on P) + Comm + Exp + Profit margin

$$P = 9562.7387 + 0.31176P + 0.02P + 0.02P + 0.01P$$

$$P = 17{,}747.03.$$

Page No.:
Date:

7) EPV of CF = EPV of prem - EPV of benefit
- EPV of Expenses + EPV of com

EPV prem = $30000 \ddot{a}_{[45]:\overline{20|}}$

= ~~300000~~ × 356640.

EPV of Benefit = $10{,}00000 \times A_{[45]:\overline{20|}}$

= ~~100~~ 327110.

EPV Expens = $5000 + 0.0225 \times 30000 (\ddot{a}_{[45]:\overline{20|}} - 1)$
$+ 500 \, l_{[45]} \times 1.06^{-1} [\ddot{a}_{[45]:\overline{20|}}]$

Renewal commission.
$= 0.02 \times 30{,}000 (\ddot{a}_{[45]:\overline{20|}} - 1)$
$= 65.33$.

PV of net CF. = 356640 - 327110 - 19438 - 6533 - I
= 3559 - I.

Margin = PV of net CF / Annual Prem
10% = (3559 - I) / 30,000
I = 559.

Page No.:
Date:

8) (i) Assumption of independent of decrement is used to derive single decrement table from multiple decrement table.

$$(a\mu)_x^j = \mu_x^j \quad \text{for all } j \text{ \& all } x.$$

(ii) In case of term assurance it is likely that people who lapse their policies have a lower than avg mortality rate

(iii)

(a) $1000 \int_0^5 e^{-\delta t} \left({}_tP_{45}^{PI} \mu_{45+t} + {}_tP_{45}^{PP} \nu_{45+t} \right) dt$

b) $250 \int_0^5 e^{-\delta t} \, {}_tP_{45}^{IP} \nu_{45+t} \, dt.$

c) $750 \int_0^5 e^{-\delta t} \, {}_tP_{45}^{PP} \nu_{45+t} \, dt.$

(10) $(aq)_{45}^{c} = \frac{0.05}{0.18}\left(1 - e^{-0.18}\right) = 0.418972.$

$(ap)_{45}^{c} = 1 - 0.04578 - 0.418922 = 0.835270$

$(aq)_{46}^{c} = \frac{0.06}{0.16}\left(1 - e^{-0.16}\right) = 0.055446$

$(aq)_{45}^{c} = \frac{0.1}{0.16}\left(1 - e^{-0.16}\right) = 0.09241$

$(ap)_{46} = 1 - 0.055446 - 0.092410 = 0.852144$

$0.835270 \times 0.852144 = 0.71176$

Page No.. Date:

a(i) In a with profit contract, the surplus on funds is distributed to the policyholder in a pre-determined manner. As the company receives surplus it is shared with the policy holders in the form of bonus. Also, company can declare bonuses on it's expectation of how well a company will do & it does not have to be fixed & hence the need of bonuses under with profit policies.

(ii) Investment surplus, Mortality surplus, Surrender surplus, Reinsurance surplus, expenses surplus.

(iii) Terminal bonus could be a strategy to build lower guarantees over the term of with profit policies. The companies would have greater freedom in choosing the investment assets, which means they can take more risk & return higher terminal bonus to policyholder.

10) EPV of premium

$12P\ddot{a}^{(12)}_{50:\overline{10|}}$ @ 6%

$$\ddot{a}^{(12)}_{50:\overline{10|}} = \ddot{a}_{50:\overline{10|}} - \frac{11}{24}\left(1 - {}_{10}p_{50} v^{10}\right)$$

$$= 7.694 - \frac{11}{24}\left(1 - (1.06)^{-10} \times \frac{9287.2164}{9712.0728}\right)$$

$$= 7.4804$$

$\therefore$ EPV of premium :- $12 \times P \times 7.4804$

$= 89.7648P$

EPV of benefits :- $10,00000 \times \left(q_{50} v \times 1.019231 v^2 {}_{1|}q_{50} + \ldots + 1.019231^{15} v^{15} {}_{15}p_{50}\right)$

$= 1000000 \times \frac{1}{1.019231} A_{50:\overline{15|}}$ @ 4%

$A_{50:\overline{15|}} = 0.56719$

$\therefore$ EPV of Benefits $= \frac{10,00,000 \times 0.56719}{1.019231}$

$= 556804.1$

EPV of expenses & commission :-

$\frac{(20+35)}{100} \times 12P + \frac{(2+1.5)}{100} \times {}_{1}p_{50}\, 1.06^{-1} \times 12P\ddot{a}^{(12)}_{51:\overline{9|}}$

$+ 2500 + 400 \times {}_{1}p_{50}\, 1.06^{-1}\, \ddot{a}_{51:\overline{4|}}$ @ 6%

$= 9.33P + 6115.06$

EPV (Prem.) = EPV (Benefit) + EPV (Expenses)

$89.7648P = 556004.1 + 9.33P + 6115.06$

$P = 7113.12$

11. $n = 20y$ with profit endowment assum.

$x = 30$, $S = 400,000$

regular bonuses $\Rightarrow$ rate of 40 per 1000 SA which vest at end of each years.

Net premium prospective reserve at times 7.

FOD -TDB

$$P \ddot{a}_{30:\overline{20}|} = 400,000 A_{30:\overline{20}|}$$

$$\ddot{a}_{30:\overline{20}|} = \ddot{a}_{30} - v^n {}_n p_x \ddot{a}_{50} = 12.06705$$

$$A_{30:\overline{20}|} = A^1_{30:\overline{20}|} + A_{30:\overline{20}|}^{\;\;1} = 0.315817$$

$$A_{30:\overline{20}|}^{\;\;1} = v^{20} {}_{20}p_{30}$$

$$P = \frac{400000 \times 0.315817}{12.06705}$$

$$= 10451.42$$

Total bonus tiel time 7

$7 \times 4\% \times 400,000 = 112000$

Guaranteed SA = $400000 + 112000 = 512000$

$\therefore$ Prospective net premium reserves at time 7.

EPV (Benefit) − EPV (Prem)

$$= 512000 A_{37:\overline{13}|} - 10451.42 \ddot{a}_{37+7}$$

$$= 143926.39$$

Page No.:
Date:

(ii) Sum assured at the end of 10^{th} years + Accrued bonuses

$X = 1000000 \times 1.02^{10}$

x 1218994.

PV of future benefit at the end of 10^{th} year

$= \frac{x}{1.05} q_{60} + \frac{x}{1.05^2} {}_{1|}q_{60} 1.04 + \ldots + \frac{x}{1.05^5} \times 1.04^5 \, {}_5 p_{60}$

= 11,60,774

PV of expenses = $400 \times \ddot{a}_{60:\overline{5|}}$ @ 5%

$= 400 \left(1 + 1.05^{-1} {}_1p_{60} + 1.05^{-2} {}_2p_{60} + \ldots + 1.05^{-4} {}_4p_{60}\right)$

= 1781.39.

Reserves required = PV of Benefit + PV of Expenses.

= 1162561