

CM1 IAI SUBJECTIVE UNIT TEST 4

Start every new question from a new page by hitting Ctrl and Enter keys together

Q1)

i) cashflow at the end of $t^{th} year =$

$$CF_t = (P - E_t) * (1 + i_t) - (aq)_x^d * D_t - (aq)_x^w * B_t - (1 - (aq)_x^d - (aq)_x^w) * S_t$$

Age mentioned is wrong in the equation, it must be $x+t-1$, marks deducted for the same

II) If the expected net value of profit is zero,

The following expression should be used to calculate the level annual premium,

$$\sum_{t=1}^n (CF)_t * (t-1)ap_x * v^{t @ j\%} = 0$$

Since it is a 3 marker, you also need to show the equation for $(ap)_x$, marks deducted for the same

iii)

$$required\ expected\ profit = {}_{t-1}V * (1 + i) + (CF)_t - {}_tV * (t-1)ap_x$$

Error in the equation, check out the original equation in the answer sheet once

[1.5+1.5+1]

[4/7]

Q2)

i) Zeroisation is the process of reducing(making zero) the losses to the company by setting up reserves in the previous years. **correct**

ii) An insurance company may choose to zeroize the above profit vector as it is facing losses in the years 2,3,4 which might lead to it not having enough funds to cover up the liabilities it has towards the policyholders. (if you would have mentioned "prudence" concept here, it would have been a strong answer. Try using such standard words in your commenting portion)

iii)

given profit vector= (751.25, -321.06, -267.57, -192.05, 201.75)

reserve required at $t=3 =$

$$3V = 192.05v @ 3.5\% = 185.55$$

$$NCUF\ at\ t = 3 = -267.57 - 185.55 * p_{62}$$

$$= -267.57 - 185.55 * (1 - 0.010112) = -451.244$$

Reserve required at $t=2=$

$$2V = 451.244v = 435.98$$

$$\begin{aligned}
 NCUF \text{ at } t = 2 &= -321.06 - 435.98 * p_{61} \\
 &= -321.06 - 435.98 * (1 - 0.009009) = -753.11
 \end{aligned}$$

Reserve required at $t=1$ =

$$\begin{aligned}
 1V &= 753.11v = 727.64 \\
 NCUF \text{ at } t = 1 &= 751.25 - 727.64 * p_{60} \\
 &= 751.25 - 727.64 * (1 - 0.008022) = 29.45
 \end{aligned}$$

Revised profit vector= (29.45,0,0,0,201.75)

Profit signature= (29.45 * 1 ,0,0,0, 201.75 * $4p_{60}$)

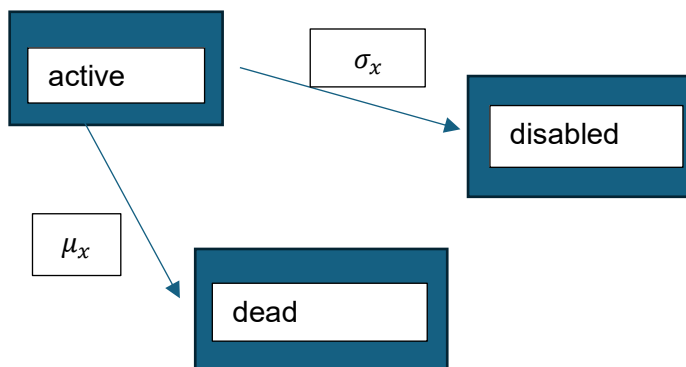
$$\begin{aligned}
 &= \left(29.45, 0, 0, 0, 201.75 * \frac{8934.8771}{9287.2164} \right) \\
 &= (29.45, 0, 0, 0, 194.095)
 \end{aligned}$$

Thus required $epv = 29.45v + 194.095v^5 = 172.822$ correct

[1+1+5]

[7/7]

Q3) i)



A third state of retirement is also required as the employees retiring is also a decrement for the company, also the transition from disabled to dead is possible, because this can determine the company's annuity stopping

ii)

required benefit=

$$20000 * 0.5 * \int_0^{65-x} e^{-\delta t} * \frac{S_{x+t}}{S_x} * tp_x^{AA} * \sigma_{x+t} * a_{x+t} dt$$

Where,

$e^{-\delta t}$ is the discount factor where δ is the force of interest

$\frac{S_{x+t}}{S_x}$ is the increase in salary from age x to age $x + t$

tp_x^{AA} is the probability of being in active state $= e^{-\int_0^t \sigma_x + \mu_x dx}$

σ_{x+t} is the rate of transition from state active to disabled

a_{x+t} is the present value of the annuity to the disabled person.

Correct, well done

[2+3]

[5/7]

Q5)

i) epv of premiums = $P \ddot{a}_{55:5}$

where $\ddot{a}_{55:5} = 17.364 - 1.04^{-5} * \frac{9826.131}{9904.805} * 15.632 = 4.6177$ correct

epv of benefits =

$$5000 * \bar{A}_{55^{1:10}} + 0.25 * 10P * v^{10} 10p55 + 5000 \ddot{a}_{55|50}^{(12)}$$

Where $\bar{A}_{55^{1:10}} = 1.04^{0.5} * A_{55^{1:10}} = 1.04^{0.5} * (A_{55} - v^{10} 10p55 * A_{65})$

$$= 1.04^{0.5} * \left(\left(1 - \frac{0.04}{1.04} * 17.364 \right) - 1.04^{-10} * \frac{9647.797}{9904.805} * \left(1 - \frac{0.04}{1.04} * 13.666 \right) \right)$$

$$= 0.0203882$$

$$\ddot{a}_{(55|50)}^{(12)} = \ddot{a}_{50}^{(12)} - \ddot{a}_{55:50}^{(12)}$$

$$= \left(19.539 - \frac{11}{24} \right) - \left(16.602 - \frac{11}{24} \right) = 2.937 \text{ correct}$$

Thus epv of benefits = $101.941 + 1.645P + 5000 * 2.937 = 14768.941 + 1.645P$

Thus premium using epv of premiums = epv of benefits (principle of equivalence) =

$$4.6177P = 14768.941 + 1.645P$$

Thus required P = 4968.2 wrong value, few areas of mistake have been marked, check them out and try reattempting the question

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Q6)

DSAR for when both lives died:

$$= 75000 * 1.04^{0.5} - 3V$$

$$3V = 75000 * 1.04^{0.5} * A_{\overline{68:63}} - 1395.11 * \ddot{a}_{\overline{68:63}}$$

$$= 75000 * 1.04^{0.5} * \left(1 - \frac{0.04}{1.04} * 16.646 \right) - 1395.11 * (12.412 + 15.606 - 11.372)$$

$$= 4294.054 \text{ correct}$$

$$\text{DSAR} = 72191.2387 \text{ correct}$$

DSAR when only male dies:

$$3V = 75000 * 1.04^{0.5} * A_{63} - 1395.11 * \ddot{a}_{63}$$

$$= 75000 * 1.04^{0.5} * \left(1 - \frac{0.04}{1.04} * 15.606\right) - 1395.11 * 15.606$$

= 8804.379 correct

DSAR= 8804.379 – 4294.054 = 4510.325 correct

DSAR when only female dies

$$3V = 75000 * 1.04^{0.5} * A_{68} - 1395.11 * \ddot{a}_{68}$$

$$= 75000 * 1.04^{0.5} * \left(1 - \frac{0.04}{1.04} * 12.412\right) - 1395.11 * 12.412$$

= 22656.285 correct

DSAR=22656.285-4294.054=18362.231 correct

Mortality profit for when both died=

$$= (5997 * 72191.2387 * q_{63} * q_{68}) - 2 * 72191.2387 = -129761.5668$$

Mortality profit for when only male dies=

$$(5997 * q_{68} * p_{63} * 4510.325) - 12 * 4510.325 = 213553.424$$

Mortality profit when nly female dies=

$$(5997 * q_{63} * p_{68} * 18362.231) - 8 * 18362.231 = 223895.58$$

Thus total mortality profit= 307687.4372 wrong value, calculations till DSAR are all correct, issue is with the euqation of mortality profit in each case, make sure to check them out

[6.5/10]

Q7)

MULTIPLE DECREMENT TABLE:

i)

x	q_x^d	q_x^s	$(aq)_x^D$	$(aq)_x^S$	$(ap)_x$	$(t-1)ap_x$
61	0.0081081	0.075	0.0081081	0.074392	0.9174999	1
62	0.0091008	0.025	0.0091008	0.024772	0.9661272	0.9174999
63	0.0102096	0	0.0102096	0	0.9897904	0.8864216

correct

Unit fund:

premium	allocation	Cost of allocation	Fund after allocation	Fund before management charges	Mgmt. charges	Fund after mgmt. charges
1500	750	705	705	736.725	7.367	729.358
2250	2362.5	2220.75	2950.108	3082.8629	30.829	3052.034
3000	3450	3243	6295.034	6578.3105	65.783	6512.528

correct

Non unit fund

Prem- correct cost of allocation	expenses correct	interest correct	Mgmt. charges correct	Claim expenses correct	Death cost (wrong)	Profit vector	Profit signature
795	275	13	7.367	6.188	45.78	488.399	488.399
29.25	111.25	-2.05	30.829	2.54	33.65	-89.411	-82.0346
-243	130	-9.325	65.783	0.76572	66.49	- 383.797	-340.206

$$\text{Required epv} = 488.399v - 82.0346v^2 - 340.206v^3 = 104.625$$

$$\text{Epv premiums} = 1500 + 2250 * 0.9174999v + 3000 * 0.8864216v^2 = 5782.945$$

$$\text{Required profit margin} = \frac{104.625}{5782.945} = 1.81\%$$

Also calculations to be the table are not shown, so only limited credits will be provided

li) the insurance company needs to set up reserves for this policy as the profit in years 2 and 3 is coming out to be negative ie losses so the company might not be able to cover up its liabilities towards the policyholders in absence of sufficient non unit reserves

iii) to zeroize:

$$(488.399, -82.0346, -340.206)$$

$$2V = 340.206v = 331.9$$

$$ncuf \text{ at } t = 2 = -82.0346 - 331.9 * 0.9661272 = -402.692$$

$$1V = 402.692v = 392.87$$

$$ncuf \text{ at } t = 1 = 488.399 - 392.87 * 0.9174999 = 127.94$$

$$\text{New profit margin} = \frac{127.94v}{5782.945} = 2.07\%$$

[8+2+3]

[13/19]

TOTAL:39.5/67

Need to avoid certain silly mistakes,

Also really need to pace up the preparation

One question left unattempted, if its because of time management issues, need to work over that area as well

All the best!!