INSTITUTE AND FACULTY OF ACTUARIES

EXAMINERS' REPORT

September 2015

Subject CT5 – Contingencies
Core Technical

Introduction

The Examiners' Report is written by the Principal Examiner with the aim of helping candidates, both those who are sitting the examination for the first time and using past papers as a revision aid and also those who have previously failed the subject.

The Examiners are charged by Council with examining the published syllabus. The Examiners have access to the Core Reading, which is designed to interpret the syllabus, and will generally base questions around it but are not required to examine the content of Core Reading specifically or exclusively.

For numerical questions the Examiners' preferred approach to the solution is reproduced in this report; other valid approaches are given appropriate credit. For essay-style questions, particularly the open-ended questions in the later subjects, the report may contain more points than the Examiners will expect from a solution that scores full marks.

The report is written based on the legislative and regulatory context pertaining to the date that the examination was set. Candidates should take into account the possibility that circumstances may have changed if using these reports for revision.

F Layton
Chairman of the Board of Examiners
December 2015

A. General comments on the *aims of this subject and how it is marked*

1. The aim of the Contingencies subject is to provide a grounding in the mathematical techniques which can be used to model and value cashflows dependent on death, survival, or other uncertain risks.

2. CT5 introduces the fundamental building blocks that stand behind all life insurance and pensions actuarial work.

3. Credit is given to students who produce alternative viable numerical solutions. In the case of descriptive answers credit is also given where appropriate valid points are made which do not appear in the solutions below.

4. In questions where definitions of symbols and then formulae are requested, a different notation system produced by a student to that used by examiners is acceptable provided it is used consistently, is relevant and is properly defined and used in the answer.

5. Students should note that for long questions reasonable credit is given if they can describe the right procedures although to score high marks reasonable accurate numerical calculation is necessary.

B. General comments on *student performance in this diet of the examination*

1. The general performance was lower in this session than the exceptionally high result of the April 2015 examination although reasonably in line with earlier sessions.

2. Well prepared students on the whole did very well in this paper in most questions. In general the questions that were done less well were 2, 8 and 12. The examiners hope that the detailed solutions given below will assist students with further revision.

3. Most of the short questions were very straightforward where an answer could be produced quickly and this is where many successful candidates scored particularly well.

4. It is worth repeating that reasonable credit was given if a student could demonstrate on the longer questions that they understood the processes required even if not all computations were accurate.

C. Comparative pass rates for the past 3 years for this diet of examination

Year	*%*
September 2015	51
April 2015	59
September 2014	52
April 2014	52
September 2013	56
April 2013	53

Reasons for any significant change in pass rates in current diet to those in the past:

See B. above.

Generally this paper was deemed to be a similar standard as those in the past except for April 2015 which students found more straightforward than anticipated. Otherwise there is reasonable consistency.

September 2015 was a little lower because of very poor experience in certain overseas centres (others performed to high standard).

Solutions

Q1 (a) $${}_{25}p_{40} = l_{65} / l_{40} = 8821.2612 / 9856.2863 = 0.894988$$

(b) $${}_{10|}q_{[53]} = d_{63} / l_{[53]} = 102.5202 / 9621.1006 = 0.010656$$

(c) $$\bar{a}_{55:\overline{10}|} = (\ddot{a}_{55} - 0.5 - v^{10}(l_{65} / l_{55})(\ddot{a}_{65} - 0.5))$$

$$= 15.873 - 0.5 - 0.67556 \times \left(\frac{8821.2612}{9557.8179}\right) \times (12.276 - 0.5)$$

$$= 8.031$$

(a) and (b) were done well.

There was a surprising poor showing on (c) where the most common error was to assume the answer was to deduct 0.5 from a 10 year life annuity due

Q2 $\Pr\left(T_x \le n\right) = 0.5$

Therefore $e^{-.01*10} \times e^{-.02*10} \times e^{-.03*(n-20)} = 0.5$

$\therefore e^{0.3-0.03n} = .5$

$\Rightarrow -0.3 + 0.03n = -\ln(0.5) = 0.69315$

$\Rightarrow n = \dfrac{0.99315}{.03} = 33.11$

So the total median future lifetime is 33 to nearest whole year

> A very simple question which was poorly done overall. Many students did not appear to know how to start the question.

Q3 (i) An overhead expense is an expense that <u>does not</u> vary with the amount of business written

A direct expense is an expense that <u>does</u> vary with the amount of business written

(ii) (a) <u>Overhead Expense</u>

Central services e.g. premises, IT, legal (allowed for on a per policy per annum basis with allowance for inflation)

<u>Direct Expense</u>

- Underwriting (allowed for on a per policy basis although medical expenses might be sum assured related)
- Processing proposal and issuing policy (allowed for on a per policy basis)
- Initial Commission (allowed for directly and usually premium related)
- Renewal Administration (allowed for on a per policy per annum basis with allowance for inflation)
- Renewal Commission (allowed for directly and usually premium related)

(b) See (a) for how expenses are allowed for (shown in brackets).

Generally well done. All reasonable descriptions were credited

Q4 (i) Education influences awareness of healthy lifestyle that reduces morbidity and hence mortality

Education includes formal education and public health campaigns

(ii) This manifests itself through many proximate determinants:

- Increased income
- Better diet choices
- Exercise
- Health care
- Moderation in alcohol consumption or smoking
- Awareness of dangers of drug abuse
- Awareness of safe sexual lifestyle

Generally well done. All reasonable descriptions were credited.

Q5 $\text{EPV} = 5000\ddot{a}_{\overline{5}|}^{(12)} + 6000\,{}_{5|}\ddot{a}_{60}^{(12)} + 1000\,{}_{10|}\ddot{a}_{60}^{(12)}$

$$= 5000 \times \left(\frac{1-v^5}{d^{(12)}}\right) + 6000 \times v^5\,{}_5p_{60}\left(\ddot{a}_{65} - 11/24\right) + 1000 \times v^{10}\,{}_{10}p_{60}\left(\ddot{a}_{70} - 11/24\right)$$

$$= 5000 \times \left(\frac{1-v^5}{0.039157}\right) + 6000v^5 \times \frac{9647.797}{9826.131} \times \left(13.666 - \frac{11}{24}\right)$$

$$+1000v^{10} \times \frac{9238.134}{9826.131} \times \left(11.562 - \frac{11}{24}\right)$$

$$= 22738.32 + 63952.31 + 7052.36$$

$$= 93743 \text{ rounded}$$

Generally well done. However many students gave themselves considerable extra work by valuing a deferred 5 year annuity for 6000 for a 5 year term at 60 and then a deferred 10 year annuity for 7000 at 60. The above approach which relies only on whole life annuities is much easier.

Q6 Using:

$$(aq)_{50}^{d} = \frac{\mu_{50}^{d}}{\mu_{50}^{d}+\mu_{50}^{w}}\left(1-e^{-(\mu_{50}^{d}+\mu_{50}^{w})}\right) = \frac{0.001}{0.151}\left(1-e^{-0.151}\right) = 0.0009282$$

$$(aq)_{50}^{w} = \frac{\mu_{50}^{w}}{\mu_{50}^{d}+\mu_{50}^{w}}\left(1-e^{-(\mu_{50}^{d}+\mu_{50}^{w})}\right) = \frac{0.15}{0.151}\left(1-e^{-0.151}\right) = 0.1392241$$

Construct a multiple decrement table assuming the radix of the table is 100,000 lives.

At age 50:

Number of deaths over year = $100,000 \times (aq)_{50}^{d} = 92.82$

Number of withdrawals over year = $100,000 \times (aq)_{50}^{w} = 13,922.41$

Age	*No of lives*	*No of deaths over year*	*No of withdrawals over year*
50	100,000.00	92.82	13,922.41
51	85,984.77		

At age 51:

$$(aq)_{51}^{d} = \frac{\mu_{51}^{d}}{\mu_{51}^{d}+\mu_{51}^{w}}\left(1-e^{-(\mu_{51}^{d}+\mu_{51}^{w})}\right) = \frac{0.0015}{0.1015}\left(1-e^{-0.1015}\right) = 0.0014264$$

Number of deaths over year = $85,984.77 \times (aq)_{51}^{d} = 122.65$

Probability that a new employee aged 50 exact will die as an employee at age 51 last birthday = 122.65 / 100,000 = 0.00123 i.e. **0.123%**

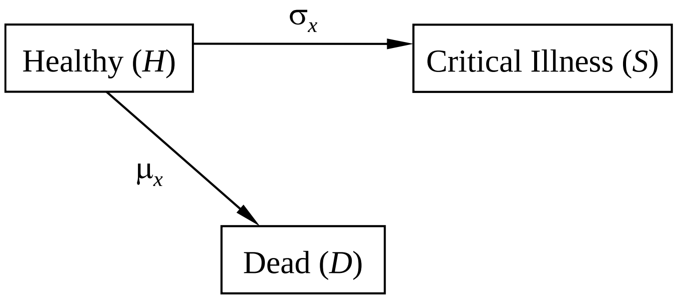
Assumption: The independent forces of mortality and withdrawal are constant over each year of age.

The above solution is a complete analysis. Note the numerical part could also be simply solved directly as follows:

$$(ap)_{50}.(aq)_{51}^{d} = e^{-(0.001+0.15)}.\frac{0.0015}{(0.1+0.0015)}\left(1-e^{-(0.1+0.0015)}\right) = 0.0012265$$

Reasonably done but many students failed to organise the probabilities properly. Full credit was given for the shorter direct approach as long as the assumptions were also stated.

Q7 Firstly we need the transition model:



The appropriate expression is:

$$EPV = \int_0^\infty 100{,}000\, e^{-\delta t}\, {}_t p_x^{HH} \left(\sigma_{x+t} + \mu_{x+t}\right) dt$$

Or

$$EPV = \int_0^\infty 100{,}000\, e^{-\delta t}\, {}_t(ap)_x \left((a\mu)_{x+t}^S + (a\mu)_{x+t}^D\right) dt$$

A very easy question generally well done. Students who drew a transition line from (*S)* to (*D)* were penalised as that did not form part of the benefit structure.

Q8 $a_{73.25}^{(4)} = 0.25\,{}_{0.25}p_{73.25}v^{0.25} + 0.25\,{}_{0.5}p_{73.25}v^{0.5} + \ddot{a}_{74}^{(4)}\,{}_{0.75}p_{73.25}v^{0.75}$

Assuming a constant force of mortality between ages 73 and 74 we are required to solve for the constant μ not using μ_{73}

$$p_{73} = 1 - q_{73} = 1 - 0.014973 = 0.985027 = e^{-\mu} \text{ hence } \mu = \ln(.985027) = 0.015086$$

$${}_{0.25}p_{73.25} = e^{-0.25\times 0.015086} = 0.996236$$

$${}_{0.5}p_{73.25} = e^{-0.5\times 0.015086} = 0.992485$$

$${}_{0.75}p_{73.25} = e^{-0.75\times 0.015086} = 0.988749$$

$$\ddot{a}_{74}^{(4)} = \ddot{a}_{74} - \frac{3}{8} = 11.333 - 0.375 = 10.958$$

Hence

$$a_{73.25}^{(4)} = 0.25 \times 0.996236 v^{0.25} + 0.25 \times 0.992485 v^{0.5} + 10.958 \times 0.988749 v^{0.75}$$

$$= 11.011$$

A question which combined a non integer age annuity using a constant force of mortality with a whole life constituent also. The question was very poorly done.

It is also possible to start with $a_{73}^{(4)}$ and deduct off the first quarter.

Q9 (i) $$\frac{25,000}{60}\left[\frac{10\left({}^{z}M_{45}^{ia} + {}^{z}M_{45}^{ra}\right) + \left({}^{z}\overline{R}_{45}^{ia} + {}^{z}\overline{R}_{45}^{ra}\right)}{s_{44}D_{45}}\right]$$

$$= \frac{25,000}{60}\left[\frac{10(52554 + 128026) + (609826 + 2244130)}{8.375 \times 2329}\right]$$

= 99,540

(ii) $$5\% \times 25,000 \times \left[\frac{{}^{s}\overline{N}_{45}}{s_{44}D_{45}}\right]$$

$$= 5\% \times 25,000 \times \left[\frac{253080}{8.375 \times 2329}\right]$$

= 16,219

An easy question generally very well done if students had prepared.

Q10 (i) The area comparability factor is the ratio of the crude mortality rate in a standard population to the crude mortality rate of a sub-population, if that sub-population exhibited standard mortality.

(ii)

	Country A			*Area N*		
Age	*Population*	*Number of deaths*	*Mortality rate*	*Population*	*Actual deaths*	*Expected deaths*
60	100,235	566	0.005647	25,366	125	143
61	95,666	621	0.006491	22,159	121	144
62	92,386	635	0.006873	21,864	135	150
Total	288,287	1,822		69,389	381	437

The area comparability factor = ((1,822/288,287) / (437/69,389)) = 1.0027 (after rounding deaths to 1 decimal place)

(iii) The directly standardised mortality rate for Area N is

(100,235 * 125/25,366 + 95,666 * 121 / 22,159
+ 92,386 * 135 / 21,864) / (100,235 + 95,666 + 92,386) = 0.0055

Note that this question is sensitive to rounding.

Generally straightforward and well done.

Q11 (i) Using the premium conversion relationship:

$$\text{Value} = 10,000 \times \bar{A}_{\overline{55:50}}$$

$$= 10,000 \times (1.04)^{1/2} \times \left(1 - \frac{.04}{1.04} \times \ddot{a}_{\overline{55:50}}\right)$$

$$= 10,000 \times (1.04)^{1/2} \times \left(1 - \frac{.04}{1.04} \times \left(\ddot{a}_{55} + \ddot{a}_{50} - \ddot{a}_{55:50}\right)\right)$$

$$= 10,000 \times (1.04)^{1/2} \times \left(1 - \frac{.04}{1.04} \times (17.364 + 19.539 - 16.602)\right)$$

$$= 2,235$$

(ii) Let the status $u = \overline{x:y}$

Then $\bar{A}_u = \int_0^\infty v^t \mu_{u+t} dt$

The second moment is $\int_0^{\infty}\left(v^t\right)^2 \mu_{u+t}dt = {}^2\bar{A}_u$

Assuming the two lives are independent then the variance is

$$(10{,}000)^2\left({}^2\bar{A}_u\right)-(10{,}000\bar{A}_u)^2$$

Alternatively:

$$\text{var}\left[10{,}000\,v^{T_{\overline{55:50}}}\right]=10{,}000^2\left\{E\left[\left(v^{T_{\overline{55:50}}}\right)^2\right]-\left(E\left[v^{T_{\overline{55:50}}}\right]\right)^2\right\}$$

$$=10{,}000^2\left\{E\left[\left(v^2\right)^{T_{\overline{55:50}}}\right]-\left(\bar{A}_{\overline{55:50}}\right)^2\right\}$$

$$=10{,}000^2\left\{{}^2\bar{A}_{\overline{55:50}}-\left(\bar{A}_{\overline{55:50}}\right)^2\right\}$$

Part (i) was done well but part (ii) gave difficulties.

It should be noted that there was a small omission in the question wording. The basis should also, of course, have included the male single mortality table. Most students gave the correct answer in any event but any student using female mortality throughout for the single life function was given full credit.

Q12

Annual premium	6000.00	Allocation % (1st yr)	98.0%
Risk discount rate	6.0%	Allocation % (2nd yr)	98.0%
Interest on investments (1st yr)	5.0%	B/O spread	6.0%
Interest on investments (2nd yr)	4.5%	Management charge	1.25%
Interest on non-unit funds (1st and 2nd yrs)	3.0%	Policy Fee	£50
Death benefit (% of bid value of units)	200%		

		% premium
Initial expense/commission	225	7.5%
Renewal expense/commission	80	2.5%
Death claim expense	90	
Maturity claim expense	55	

Mortality table:

x	t	$q^d_{[x]+t-1}$	$q^s_{[x]+t-1}$	$(aq)^d_{[x]+t-1}$	$(aq)^s_{[x]+t-1}$	$(ap)_{[x]+t-1}$	${}_{t-1}(ap)_{[x]}$
45	1	0.001201	0.02500	0.001201	0.02497	0.973829	1.000000
46	2	0.001557	0.00000	0.001557	0.00000	0.998443	0.973829

Unit fund (per policy at start of year)

	yr 1	*yr 2*
value of units at start of year	0.000	5679.172
alloc	5880.000	5880.000
B/O	–352.80	–352.800
policy fee	–50.000	–50.000
interest	273.860	502.037
management charge	–71.888	–145.730
value of units at year end	5679.172	11512.678

Non Unit fund cash flows (per policy at start of year)

	yr 1	*yr 2*
unallocated premium + policy fee	170.000	170.000
b/o spread	352.800	352.800
expenses	–675.000	–230.000
interest	–4.566	8.784
man charge	71.888	145.730
extra death benefit	-6.821	–17.925
surrender penalty	12.485	0.000
claim expense (death/maturity)	–0.108	–55.054
end of year cash flow	–79.322	374.335

(i) (a) if p/h dies in the 1st year of contract, non unit cash flows at end of the year are:

$yr1 = (170 + 352.80 - 675 - 4.566 + 71.888 - 5679.172 - 90) = -5854.050$

(b) if p/h surrenders in the 1st year of contract, non unit cash flows at end of the year are:

$yr1 = (170 + 352.80 - 675 - 4.566 + 71.888 + 500) = 415.122$

(c) if p/h dies in the 2nd year of contract, non unit cash flows at end of each year are:

$$yr1 = (170 + 352.80 - 675 - 4.566 + 71.888) = -84.878$$

$$yr\ 2 = (170 + 352.8 - 230 + 8.784 + 145.73 - 11512.678 - 90) = -11155.364$$

(d) if p/h survives to the end of the contract, non unit cash flows at end of each year are:

$yr\ 1 = -84.878$ (derived above)

$$yr\ 2 = (170 + 352.8 - 230 + 8.784 + 145.73 - 55) = 392.314$$

(ii) (a) if p/h dies in the 1st year of contract, expected present value of profit is given by:

$$-5854.050 \times v \times (aq)^{d}_{[45]} = -5522.689 \times 0.001201 = -6.633$$

(b) if p/h surrenders in the 1st year of contract, expected present value of profit is given by:

$$415.122 \times v \times (aq)^{s}_{[45]} = 391.624 \times 0.02497 = 9.779$$

(c) if p/h dies in the 2nd year of contract, expected present value of profit is given by:

$$\left[-84.878 \times v - 11155.364 \times v^2\right] \times (ap)_{[45]} \times (aq)^{d}_{[45]+1}$$

$$= [-80.074 - 9928.234] \times 0.973829 \times 0.001557 = -15.175$$

(d) if p/h survives to the end of the contract, expected present value of profit is given by:

$$\left[-84.878 \times v + 392.314 \times v^2\right] \times {}_2(ap)_{[45]}$$

$$= [-80.074 + 349.158] \times 0.973829 \times 0.998443 = 261.634$$

(iii) Expected present value of the profit of the policy is therefore

$= -6.633 + 9.779 - 15.175 + 261.634 =$ **249.605**

> This question proved to be the most difficult on the paper and was in general poorly done. In essence the question was about breaking the final Present Value of Future Profits down into constituent parts which would need to be carried out in any event and each part in itself is relatively straightforward.
>
> Reasonable partial credit was given if a good understanding was shown without the calculations being fully accurate.

Q13 (i) Let P be the monthly premium for the contract. Then:

EPV of premiums is:

$$12P\ddot{a}^{(12)}_{[40]:\overline{25|}} = 12P\left[\ddot{a}_{[40]:\overline{25|}} - \frac{11}{24}\left(1 - v^{25}\,{}_{25}p_{[40]}\right)\right]$$

$$= 12P\left[15.887 - \frac{11}{24}\left(1 - 0.37512 \times \frac{8821.2612}{9854.3036}\right)\right]$$

$$= 186.9909P$$

EPV of death benefits:

$$260{,}000\bar{A}^{1}_{[40]:\overline{25|}} - 10{,}000\left(I\bar{A}\right)^{1}_{[40]:\overline{25|}} = 10{,}000 \times (1.04)^{0.5}\left[26A^{1}_{[40]:\overline{25|}} - (IA)^{1}_{[40]:\overline{25|}}\right]$$

$$= 10198.04\left[26 \times 0.05316 - 0.87602\right] = 5161.64$$

where

$$A^{1}_{[40]:\overline{25|}} = A_{[40]:\overline{25|}} - v^{25}\,{}_{25}p_{[40]} = 0.38896 - 0.33580 = 0.05316$$

and

$$(IA)^{1}_{[40]:\overline{25|}} = (IA)_{[40]} - v^{25}\,{}_{25}p_{[40]}\left[25A_{65} + (IA)_{65}\right]$$

$$= 7.95835 - 0.33580\left[25 \times 0.52786 + 7.89442\right] = 0.87602$$

EPV of annuity:

$$v^{25}\,{}_{25}p_{[40]}\left[28500\ddot{a}_{65}+1500\left(I\ddot{a}\right)_{65}\right]$$

$$=0.33580\left[28500\times 12.276+1500\times 113.911\right]=174{,}861.97$$

EPV of expenses:

(a) Death claim

$$275\left[1.04^{0.5}q_{[40]}v^{0.5}+1.04^{1.5}\,p_{[40]}q_{[40]+1}v^{1.5}+.....+1.04^{24.5}\,{}_{24}p_{[40]}q_{64}v^{24.5}\right]$$

$$=275\times {}_{25}q_{[40]}=275\left(1-0.895168\right)=28.83$$

(b) Annuity

0.025 × *EPV* of annuity = 4,371.55

(c) Premium related

$$0.35\times 12P+0.05\times 12P\left[\ddot{a}^{(12)}_{[40]:\overline{25|}}-\frac{1}{12}\right]=4.2P+0.6P\times\left(15.5826-0.08333\right)$$

$$=13.49956P$$

(d) Other

$$225+55\left(\ddot{a}^{@0\%}_{[40]:\overline{25|}}-1\right)=225+55\left(e_{[40]}-\frac{l_{65}}{l_{[40]}}\left(1+e_{65}\right)\right)$$

$$=225+55\left(39.071-\frac{8821.2612}{9854.3036}\times 17.645\right)=1505.17$$

Equation of value gives:

$$186.9909P=5161.64+174861.97+28.83+4371.55$$
$$+13.49956P+1505.17$$

$$\Rightarrow 173.49134P=185929.16$$

$$\Rightarrow P=£1071.69$$

A typical CT5 question, well done by prepared students.

The only real uncertainty was treatment of the death claim expenses.

Again reasonable partial credit was given for understanding without full computational accuracy.

Q14 (i) The death strain at risk for a policy for year t + 1 (t = 0, 1, 2…) is the excess of the sum assured (i.e. the present value at time t + 1 of all benefits payable on death during the year t + 1) over the end of year reserve and any benefit payable if the life survives to the end of year t + 1.

i.e. DSAR for year $t + 1 = S - \left({}_{t+1}V + R\right)$

(ii) Annual premium for pure endowment with £75,000 sum assured given by:

$$P^{PE} = \frac{75{,}000}{\ddot{a}_{55:\overline{5}|}} \times v^5 \times {}_5p_{55} = \frac{75{,}000}{4.585} \times 0.82193 \times \frac{9287.2164}{9557.8179} = 13{,}064.223$$

Annual premium for term assurance with £75,000 sum assured given by:

$$P^{TA} = P^{EA} - P^{PE} = \frac{75{,}000 A_{55:\overline{5}|}}{\ddot{a}_{55:\overline{5}|}} - P^{PE}$$

$$= \frac{75{,}000 \times 0.82365}{4.585} - 13{,}064.223 = 408.786$$

Reserves at the end of the fourth policy year:

for pure endowment with £75,000 sum assured given by:

$${}_4V^{PE} = 75{,}000 \times v \times {}_1p_{59} - P^{PE} \ddot{a}_{59:\overline{1}|}$$

$$= 75{,}000 \times 0.96154 \times \frac{9287.2164}{9354.0040} - 13{,}064.223 = 58{,}536.372$$

for term assurance with £75,000 sum assured given by:

$${}_4V^{TA} = {}_4V^{EA} - {}_4V^{PE}$$

$$= 75{,}000 A_{59:\overline{1}|} - (13{,}064.223 + 408.786)\ddot{a}_{59:\overline{1}|} - 58{,}536.372$$

$$= 75{,}000 \times 0.96154 - (13{,}064.223 + 408.786) \times 1 - 58{,}536.372 = 106.119$$

for temporary immediate annuity paying an annual benefit of £15,000 given by:

$$ {}_4V^{IA} = 15,000 a_{\overline{59:1}|} $$

$$ = 15,000 \times v \times {}_1p_{59} = 15,000 \times 0.96154 \times \frac{9826.131}{9846.908} $$

$$ = 14,392.644 $$

Death strain at risk per policy:

Pure endowment: DSAR = 0 − 58,536.372 = –58,536.372

Term assurance: DSAR = 75,000 – 106.119 = 74,893.881

Immediate annuity: DSAR = 0 – (14,392.644 + 15,000) = –29,392.644

(iii) Mortality profit = EDS – ADS

For pure endowment

$$ EDS = 984 \times q_{58} \times -58,536.372 = 984 \times .006352 \times -58,536.372 = -365,873.866 $$

$$ ADS = 5 \times -58,536.372 = -292,681.86 $$

mortality profit = –73,192.00

For term assurance

$$ EDS = 3950 \times q_{58} \times 74,893.881 = 3950 \times .006352 \times 74,893.881 = 1,879,117.432 $$

$$ ADS = 22 \times 74,893.881 = 1,647,665.382 $$

mortality profit = 231,452.05

For temporary immediate annuity

$$ EDS = 495 \times q_{58} \times -29,392.644 = 495 \times .001814 \times -29,392.644 = -26,391.746 $$

$$ ADS = 2 \times -29,392.644 = -58,785.288 $$

mortality profit = 32,393.54

Hence, total mortality profit = –73,192.00 + 231,452.05 + 32,393.54

= £190,653.59

Another typical CT5 question which was well done by prepared students. Again reasonable partial credit was given for understanding without full computational accuracy.

END OF EXAMINERS' REPORT