EXAMINATION

28 April 2009 (pm)

Subject CA3 — Communications

Time allowed: Three hours

INSTRUCTIONS TO THE CANDIDATE

1. *Enter all the candidate and examination details as requested on the front of your answer booklet.*

2. *You have 15 minutes before the start of the examination in which to read the questions. You are strongly encouraged to use this time for reading only, but notes may be made. You then have three hours to complete the paper.*

3. *You must not start writing your answers in the booklet until instructed to do so by the supervisor.*

4. *Attempt Question 1 AND Question 2.*

AT THE END OF THE EXAMINATION

Hand in BOTH your answer booklet, with any additional sheets firmly attached, and this question paper.

In addition to this paper you should have available the 2002 edition of the Formulae and Tables and your own electronic calculator from the approved list.

1 You are a manager of an actuarial department in a life insurance company working with a large portfolio of annuities. A colleague from your finance department has heard the word “immunisation” mentioned in a meeting in relation to investment in bonds, and asked if you could explain what it meant.

Draft a memo of 350 to 450 words to explain what immunisation means, when it can be used, how it works and the benefits that it can bring. You should include a simple example.

A member of your team has provided you with the information below for you.

John,

We use the theory of immunisation when matching policy liabilities with known monetary cash flows. An example is our non-profit, non-linked, immediate annuity sub-fund, where we have a large number of lives and hence a well-established view of the monetary cash flows, representing both policyholder payment and changes in expense reserves.

I’ve found the following extracts from some technical papers.

There are potentially two risks that the holder of a default-free bond is exposed to:

1. If the bonds are not held to maturity, there is a price risk, ie the price at which the bond is sold at some future date is unknown.

2. The rate at which each coupon payment can be reinvested is unknown — this is called the reinvestment risk.

Consider an example of a 10-year bond, X, with a coupon of 5% and currently priced at par (i.e. 100). It has a gross redemption yield of 5%. However the investor in such a bond is most unlikely to achieve a return of 5% if he holds the bond to maturity.

The gross redemption yield of a bond is simply the average rate at which the sum of the future coupon payments and redemption proceeds are discounted to equate their value to the current market price. Therefore it is assumed that the coupon payments can be reinvested at this average rate, i.e. “interest on interest” is at the gross redemption yield. But in practice, the coupon payments can only be reinvested at the market rates operative when the coupon is received. There is therefore a reinvestment rate risk if the bond is held until coupons are received. If the reinvestment rate is higher than the redemption yield then the actual return on the bond, assuming it is held to maturity, will be higher than the redemption yield. If the reinvestment rate is lower than the redemption yield, the opposite is true. All coupon-bearing bonds carry this reinvestment rate risk to a greater or lesser extent — the higher the coupon the greater the risk.

It is possible to eliminate the reinvestment risk on a coupon-bearing bond, even with unknown reinvestment rates, under certain market conditions. This is done quite simply by holding a bond (or a portfolio of bonds) over a period — known as the holding period — equal to its duration. The performance of the bond is thus independent of the unknown future reinvestment rate over the holding period. This result is achieved because the higher (lower) reinvestment rates are exactly offset by the lower (higher) bond prices, i.e. the price risk and the reinvestment risk exactly cancel out. This is known as immunisation.

Thus the objective of an immunised portfolio is to assure — with a high degree of probability — that a fixed return over the holding period is achieved, irrespective of future reinvestment rates. It is typically used in respect of liabilities with cash-flows of known monetary amounts, such as non-profit annuity technical liabilities.

Consider a simple example:

- £10m nominal of a 10-year bond with a coupon of 5% priced at par.
- £10m nominal of a 20-year bond with a coupon of 5% also priced at par.

The projected cash flows from this are:

Year	*10-year bond coupons £m*	*10-year bond maturity £m*	*20-year bond coupons £m*	*20-year bond maturity £m*	*Total £m*
1	0.5		0.5		1.0
2	0.5		0.5		1.0
3	0.5		0.5		1.0
4	0.5		0.5		1.0
5	0.5		0.5		1.0
6	0.5		0.5		1.0
7	0.5		0.5		1.0
8	0.5		0.5		1.0
9	0.5		0.5		1.0
10	0.5	10	0.5		11.0
11			0.5		0.5
12			0.5		0.5
13			0.5		0.5
14			0.5		0.5
15			0.5		0.5
16			0.5		0.5
17			0.5		0.5
18			0.5		0.5
19			0.5		0.5
20			0.5	10	10.5

The current value of these bonds changes according to market interest rates:

Value at different interest rates (£m) of a bond with a 5% coupon

Term	*2%*	*3%*	*4%*	*5%*	*6%*	*7%*	*8%*
10 years	£12.695	£11.706	£10.811	£10.000	£9.264	£8.595	£7.987
20 years	£14.905	£12.975	£11.359	£10.000	£8.853	£7.881	£7.055
Total	£27.600	£24.681	£22.170	£20.000	£18.117	£16.476	£15.042

Note that the market impact of change in interest rates is different for the two bonds.

If the liability profile was approximately equal to that for a 15 year bond also paying a coupon at 5%, the impact of different market interest rates would be:

Value at different interest rates (£m) of a bond with a 5% coupon

Term	*2%*	*3%*	*4%*	*5%*	*6%*	*7%*	*8%*
15 years	£13.855	£12.388	£11.112	£10.000	£9.029	£8.178	£7.432

As can be seen, the values at different rates are different to both the 10-year and 20-year bonds. However, looking at £20m of the 15 year bond, compared to the total of the 10 and 20-year bond gives the following result:

Value at different interest rates (£m) of a bond with a 5% coupon

Term	*2%*	*3%*	*4%*	*5%*	*6%*	*7%*	*8%*
10 & 20 yrs	£27.60	£24.68	£22.17	£20.00	£18.12	£16.48	£15.04
15 years	£27.71	£24.78	£22.22	£20.00	£18.06	£16.36	£14.86
Difference	–£0.11	–£0.09	–£0.05	£0.00	£0.06	£0.12	£0.18

As can be seen — by holding a mixture of 10 and 20-year bonds, the total value of assets moves in a very similar way to the hypothetical liability profile.

There are two potential problems that have to be overcome before immunisation can be successfully applied in practice. Firstly the duration of a bond generally decreases less rapidly over time than its maturity, other factors being unchanged. Secondly, interest rates will vary during the holding period in a way which is unknown at the outset and this will alter the duration of the bond.

Hence, it is most unlikely that immunisation can be carried out successfully unless (a) several bonds are held in the portfolio and (b) the bonds are traded in order that the duration of the portfolio at any time is equal to the unexpired term of the holding period. This trading mechanism is called rebalancing.

Note: The duration of an n-year coupon paying bond, with coupons of D payable annually, redeemed at maturity date R is:

$$Duration = \frac{D(Ia)_{\overline{n|}} + Rnv^n}{Da_{\overline{n|}} + Rv^n}$$

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2 You are an actuary working in an insurance company's general insurance department. On 1 January 2007 your company launched a new pet insurance product.

To increase market share in 2009 your company has made changes to the policy terms in order to make the policy more attractive to customers. The main decision has been to reduce the policy excess compared to 2007. However, your company has become concerned that there has been a large decline in the number of policyholders renewing their policies.

The marketing manager has passed you the details of its insurance policy covering cats, where many policyholders have failed to renew due to the much higher premium. The details are as follows:

	Policy terms for 2007	*Policy terms for 2009*
Breed of cat	any	any
Age of cat	3–5 years	3–5 years
Location	London	London
Compulsory excess for each claim	£60	£40
Maximum Vet fees payable per claim	£8,000	£4,000
Premium	£60 p.a.	£100 p.a.

The following figures have been produced on your company's claims for 2007:

Claim amounts in first policy year (before deduction of excess) (£)*	*Number of claims*
0–60	12,000**
60–100	25,000
100–500	5,000
500–4,000	500
4,000–10,000	10

*assume claim amounts are evenly distributed in each claim band
**no claims were paid in this category, as claim amounts did not exceed the excess

The marketing manager has asked you to explain why the premium has increased so much when, on the face of it, there has been only a modest reduction in the excess and a large reduction in the maximum policy payout.

Draft a memo of 450–550 words to the marketing manager explaining why the premium has increased so much. You should explain with an example the impact of the lower excess on the number of claims paid out, and the impact of the lower maximum payout. Your answer should also consider the impact of per claim expenses on overall administration costs.

You should:

- Assume all potential claims have to be notified to the insurer even if they are below the excess
- Assume all information in the question is correct and that detailed calculations are not required
- Ignore other external factors such as tax and commission

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END OF PAPER