1. A whole life insurance policy on (75) has a death benefit of 100,000 paid at the end of the year of death. The annual gross premium is 9700.

   Chenxi performs a profit test on this policy. The interest rate used in the profit test is 8%. Mortality follows the Standard Ultimate Life Table.

   The other profit test information is listed below for the first four years:

Year	Withdrawals	Reserve End of Year	Percent of Premium Expense	Per Policy Expense
1	20%	3,710	60%	125
2	10%	7,390	10%	25
3	8%	11,033	5%	25
4	4%	14,625	2%	25

   Withdrawals occur at the end of the year. Cash values are equal to 80% of the reserves.

   Calculate π_2 which is the profit signature for the second year.

   Solution:

$$\begin{aligned}\Pr_2 &= (3710+9700-(0.1)(9700)-25)(1.08)-(100,000)(0.020668)\\ &\quad -(7390)(0.8)(1-0.020668)(0.1)-(7390)(1-0.020668)(1-0.1)=4248.88\end{aligned}$$

$$\pi_2 = \Pr_2 \cdot {}_1p_{75}^{(\tau)} = (4248.88)(1-0.018433)(1-0.2) = 3336.45$$

2. You are given the following profit vector for a whole life issued to (94):

t	Pr_t
0	-900
1	700
2	500
3	300
4	100

Mortality is the only decrement and follows the table below:

x	l_x
92	2500
93	2250
94	2000
95	1600
96	960
97	384
98	0

The gross premium used in the profit test is 1000.

Calculate the Profit Margin for this profit test using an interest rate of 8%.

Solution:

$$PM = \frac{NPV}{PVP}$$

$$= \frac{-900 + 700(1.08)^{-1} + 500\left(\frac{1600}{2000}\right)(1.08)^{-2} + 300\left(\frac{960}{2000}\right)(1.08)^{-3} + 100\left(\frac{384}{2000}\right)(1.08)^{-4}}{1000\left[1 + \frac{1600}{2000}(1.08)^{-1} + \frac{960}{2000}(1.08)^{-2} + \frac{384}{2000}(1.08)^{-3}\right]}$$

$$= \frac{219.508}{2304.68} = 0.0953$$

3. You are given $c = 1.04,\ j = 5\%,\ i = 7\%$.

   Calculate i^* .

   Solution:

$$1 + i^* = \frac{1+i}{c(1+j)} = \frac{1.07}{(1.04)(1.05)} = 0.97985$$

$$i^* = 0.97985 - 1 = -0.02015$$