1. (13 points) The Li Life Insurance Company sells a survivor whole life policy to (60) and (70). The death benefit of 1,000,000 is paid at the end of the year of the second death.

   Net benefit premiums are paid annually as long as one of the insureds is alive, but the premium varies depending on how many insureds are alive. If both insureds are alive, the net benefit premium is P. If only one of the insureds is alive, then the net benefit premium to be paid is $0.4P$.

   You are given:

   i. $i = 0.08$
   ii. $1000A_{60} = 325$
   iii. $1000A_{70} = 450$
   iv. $1000A_{60:70} = 500$

   Calculate P.

2. Chengtao has worked for the consulting firm of Yang and Wang for the last 10 years. Chengtao is exact age 53 today. His salary during the last year was 142,000. During the 10 years that he has worked at Yang and Wang, he has earned a total salary of 1,250,00.

Yang and Wang provides a defined benefit plan. The benefit to be paid will be 1.75% for each year of service times that average salary during Chentao's last five years. The benefit will be paid annually at the beginning of the year as a single life annuity with the first 10 years of payments guaranteed.

Mortality after retirement follows the Illustrative Life Table. We also assume that after retirement, the plan will earn an annual effective interest rate of 6%.

The plan assumes that Chengtao's salary will increase by 4% on each birthdate including today.

   a. (10 points) Assuming that Chengtao retires at exact age 68, calculate the annual benefit that Chengtao will receive.

    b. (4 points) Calculate Chengtao's replacement ratio.

    c. (8 points) Calculate the amount that the pension plan will need to have at the time that Chengtao retires to fund the pension plan.

3. (10 points) Zihe is exact age 65 and still working. She could retire today or on any of her birthdays during the next five years. Zihe's probability of retirement follows the Illustrative Service Table with retirements occurring on her birthdays. In other words, the retirements listed for age 65 occur on the 65th birthday. The retirements listed for age 66 occur on the 66th birthday, etc.

Whenever she retires, she will receive a single lump sum payment of 600,000 with the payment being made on the date of retirement.

Using an interest rate of 5%, calculate the Actuarial Present Value of Zihe's retirement payment.

4. Huining who is (60) and Mengyun who is (65) are best friends. They travel together all the time. Therefore, their mortality is subject to a common shock.

   Mortality for Huining and Mengyun follows the Illustrative Life Table but this mortality does not include the common shock mortality. The common shock mortality is based on a constant force of mortality of $\mu_x^{CommonShock} = 0.01$ for all x.

   a. (10 points) Calculate the probability that both Huining and Mengyun will be alive at the end of five years from today.

   b. (10 points) Calculate the probability that the first death among the two of them will occur between five and ten years from today.

5. A multiple decrement model has three decrements. Decrement (d) is death. Decrement (c) is critical illness. Decrement (w) is withdrawal.

You are given the following multiple decrement table:

Age	$q_x^{(d)}$	$q_x^{(c)}$	$q_x^{(w)}$
70	0.04	0.08	0.10
71	0.06	0.12	0.05

A two year term insurance is issued to (70) with a death benefit of 130,000 paid at the end of the year of death. It will also pay a benefit of 100,000 at the end of the year of the occurrence of a critical illness. If a critical illness benefit is paid, then no subsequent benefit is paid upon death. No benefit is paid on withdrawal. Annual premiums will be paid for two years if the insured is active.

You are given that the annual effective interest rate is 8%.

a. (13 points) Calculate the net annual benefit premium for this term policy.

b. (7 points) Calculate the reserve at the end of one year.

6. (15 points) The Tang Insurance Company has 100,000 people age 80 who are subject to two decrements – death (d) and withdrawal (w). Using a double decrement table derived from independent single decrement tables, Tang wants to estimate the number of withdrawals during the next year.

You are given $q_{80}^{\prime(w)} = 0.20$ and $q_{80}^{\prime(d)} = 0.12$.

Jack calculated the expected number of withdrawals assuming that decrements are uniformly distributed in the single decrement tables. His expectation is J.

Tania calculated the expected number of withdrawals assuming that decrements are uniformly distributed in the multiple decrement table. Her expectation is T.

Calculate $J - T$.