1. For a special whole life insurance on (45), you are given:
   - Death benefit is payable at the end of the year of death.
   - Death benefit is $10,000 during the first 10 years, and $20,000 thereafter.
   - Mortality follows the Illustrative Life Table.
   - \( i = 6\% \)

   Calculate the actuarial present value of this insurance.

2. For a cohort of individuals all age \( x \) consisting of 80% non-smokers (ns) and 20% smokers (sm), you are given:

\[
\begin{array}{ccc}
  k & q_{x+k}^{\text{ns}} & q_{x+k}^{\text{sm}} \\
  0 & 0.02 & 0.08 \\
  1 & 0.04 & 0.15 \\
  2 & 0.06 & 0.20 \\
\end{array}
\]

Calculate \( A_{10}^{1}[x;2] \) for a randomly chosen individual from this cohort. You are given: \( i = 3\% \).

3. For a whole life insurance of $100 issued to (65), you are given:
   - Death benefits are payable at the end of the year of death.
   - Mortality follows the Illustrative Life Table with the exception of the first year where you are given that \( q_{65} = 0.03 \).
   - The annual effective interest rate is 2% in the first year, 3% in the second year, and 6% each year thereafter.

   Calculate the actuarial present value of the death benefits.

4. You are given:
   - \( \bar{a}_{60:10} = 6.50 \);
   - \( A_{60:10}^{1} = 0.08 \); and
   - \( v = 0.92 \).
Calculate the actuarial present value of a 10-year pure endowment issued to (60). Calculate the variance of the present value of the benefits for this same pure endowment.

5. You are given:
   - Deaths are uniformly distributed over each year of age.
   - \( q_x = 0.05 \)
   - \( q_{x+1} = 0.08 \)
   - \( i = 5\% \)

   (a) Evaluate \( \bar{A}_{\overline{x:2}}^1 \)
   (b) Evaluate \( 2\bar{A}_{\overline{x:2}}^1 \)
   (c) Explain verbally the benefits provided by \( \bar{A}_{\overline{x:2}}^1 \)

6. You are given:
   - \( Z \) is the present value random variable for a whole life insurance of 1 payable at the moment of death of (50).
   - Mortality follows de Moivre’s law.
   - \( \delta = 5\% \)
   - The probability that \( Z \) exceeds 0.0734 is 0.95.

   Calculate \( \omega \) in the de Moivre’s law.

7. Suppose you are given the following extract from a select-and-ultimate mortality table:

   \[
   \begin{array}{cccccc}
   x & \ell_x & \ell_{x+1} & \ell_{x+2} & \ell_{x+3} & x+3 \\
   \hline
   55 & 882 & 877 & 871 & 864 & 58 \\
   56 & 875 & 870 & 863 & 856 & 59 \\
   57 & 868 & 863 & 856 & 849 & 60 \\
   58 & 861 & 855 & 848 & 840 & 61 \\
   59 & 854 & 847 & 840 & 832 & 62 \\
   60 & 846 & 839 & 832 & 823 & 63 \\
   \end{array}
   \]

   Calculate \( \ddot{a}_{\overline{57:3}} \) if \( i = 5\% \).

8. For a whole life annuity-due issued to (50), you are given:
   - The annual benefit is 100.
   - Mortality follows the *Illustrative Life Table*.
   - \( i = 6\% \)
Calculate the variance of the present value of the benefits for this annuity.

9. (See also Exercise 5.7) You are given:
   - $\ddot{a}_x = 11.2$
   - $15\ddot{a}_x = 4.5$
   - $A_{x:15}^1 = 0.212$
   - $15E_x = 0.255$

   Calculate $i$.

10. For a special 10-year term insurance on (35), you are given:
    - Death benefits are payable at the end of the year of death.
    - The death benefit is 100 in years 1-5 and increases to 200 in years 5-10.
    - Mortality follows the Illustrative Life Table.
    - $i = 6\%$
    - $Z$ denotes the present value, at age 35, of these death benefits.

   (a) Write an expression for $Z$ in terms of the curtate future lifetime of (35), say $K$.
   (b) Calculate $Pr[Z = 0]$.
   (c) Calculate $Pr[Z > 85]$.
   (d) Calculate $E[Z]$. 