Instructions:

1. Answer question 1 (Compulsory) and ANY other 2 questions
2. Candidates are advised not to write on the question paper.
3. Candidates must hand in their answer booklets to the invigilator while in the examination room.
QUESTION 1 [30 marks]

a).Explain with examples, 3 distinct types of selection in the membership of a pension scheme. [6 marks]

b).Sketch the graph of a general human mortality pattern and explain the graph. [7 marks]

c).Suppose that the life table function is given by \( l_x = 20,900 - 80x - x^2 \)

(i) compute the radix if \( \alpha = 0 \) and the limiting age for the life table [5 marks]

(ii) Compute \( p_{x} \), \( q_{x} \) and \( u_{x} \) [6 marks]

d) Given the survival function \( s(x) = \left(1 - \frac{x}{100}\right)^2 \) for \( 0 \leq x \leq 100 \)

Find : [6 marks]

(i) \( \mu(x) \)

(ii) \( f(x) \)

QUESTION 2 [20 marks]

a) .Describe how selection can arise in pension schemes. [6 marks]

b). Describe how occupation affects mortality and morbidity [4 marks]

c).Describe the casual factors that explain the differences in mortality and morbidity. [6 marks]

d).Explain how an insurance company uses risk classification to control the profitability of its life insurance business [4 marks]

QUESTION 3 [20 marks]

a)Explain what is meant by the following terms and give an example of each [8 marks]

   i. Temporary initial selection
   ii. Time selection
   iii. Spurious selection
   iv. Class selection

   QUESTION 3 [20 marks]

   a)Explain what is meant by the following terms and give an example of each [8 marks]

   i. Temporary initial selection
   ii. Time selection
   iii. Spurious selection
   iv. Class selection
b. Given \( p_{30} = \frac{7800 - 70t - t^2}{7800} \) for \( 0 \leq t \leq 100 - x \)

(i) Find \( 10p_{30} \) and \( 1p_{30} \) and hence find \( q_{31} \) \[4 \text{ marks}\]

(ii) Find \( \mu_{30+t} \) and then \( \mu_{30} \) and \( \mu_{40} \) \[4 \text{ marks}\]

(iii) Calculate \( 10p_{31} \) assuming \( \mu_{40} \) to be constant between ages 40 and 41 \[4 \text{ marks}\]

**QUESTION 4 [20 marks]**

a) The abridged life table below data in the table below refers to the female population of England and Wales in 1980-1982

<table>
<thead>
<tr>
<th>( x )</th>
<th>( l_x )</th>
<th>( T_x )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100000</td>
<td>7700187</td>
</tr>
<tr>
<td>1</td>
<td>99016</td>
<td>7601014</td>
</tr>
<tr>
<td>10</td>
<td>98746</td>
<td>6711410</td>
</tr>
<tr>
<td>20</td>
<td>98497</td>
<td>5725004</td>
</tr>
<tr>
<td>30</td>
<td>98105</td>
<td>4741877</td>
</tr>
<tr>
<td>40</td>
<td>97346</td>
<td>3764073</td>
</tr>
</tbody>
</table>

Using these data calculate

(i) The probability that a woman aged exactly 20 will survive until her 40\(^{th}\) birthday \[3 \text{ marks}\]

(ii) The infant mortality rate \( q_o \) \[2 \text{ marks}\]

(iii) The life expectation at birth and at exact age 1 year \[3 \text{ marks}\]

(iv) The probability that a girl who survives until her first birthday will die between her 10\(^{th}\) and 20\(^{th}\) birthdays \[3 \text{ marks}\]

(v) The expected age at death of those who die between their 20\(^{th}\) and 30\(^{th}\) birthdays: Use two alternative ways \[3 \text{ marks}\]

(vi) The expected age at death of those who die when they are aged under 1 year: Use two alternative ways \[3 \text{ marks}\]
b). In a certain population, $\mu_x$ is given by

<table>
<thead>
<tr>
<th>Interval</th>
<th>$\mu_x$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$60 \leq x \leq 70$</td>
<td>0.01</td>
</tr>
<tr>
<td>$70 \leq x \leq 80$</td>
<td>0.015</td>
</tr>
<tr>
<td>$x &gt; 80$</td>
<td>0.025</td>
</tr>
</tbody>
</table>

Calculate the probability that a life aged exactly 65 will die between ages 80 and 83 [3 marks]

**QUESTION 5 [20 marks]**

You are given the following data from 2 populations

<table>
<thead>
<tr>
<th>MADE UP TOWN</th>
<th>STANDARD POPULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>sex</td>
<td>occupation</td>
</tr>
<tr>
<td>Male</td>
<td>Office worker</td>
</tr>
<tr>
<td></td>
<td>Manual worker</td>
</tr>
<tr>
<td></td>
<td>other</td>
</tr>
<tr>
<td>Female</td>
<td>Office worker</td>
</tr>
<tr>
<td></td>
<td>Manual worker</td>
</tr>
<tr>
<td></td>
<td>other</td>
</tr>
</tbody>
</table>

Calculate the directly standardized mortality of Made up town by standardizing by

i. Occupation

ii. Sex

iii. Occupation and sex [20 marks]