1. (8 points) You are the actuary for a company that sponsors two single participant, non-contributory defined benefit pension plans.

You are given, as of January 1, 1999:

<table>
<thead>
<tr>
<th>Plan Provisions</th>
<th>Plan A</th>
<th>Plan B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retirement Benefit</td>
<td>1.8% of final year’s earnings times service</td>
<td>2.0% of final year’s earnings times service</td>
</tr>
<tr>
<td>Normal Form of Pension</td>
<td>Life only, payable monthly in advance</td>
<td>Life only, payable monthly in advance</td>
</tr>
<tr>
<td>Normal Retirement Date</td>
<td>Age 65</td>
<td>Age 65</td>
</tr>
<tr>
<td>Other Ancillary Benefits</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

**Actuarial Assumptions & Method**

| Interest Rate                  | 7.0% per year                      | 8.0% per year                      |
| Salary Scale                   | 4.5% per year, at end of year      | 6.0% per year, at end of year      |
| Retirement Age                 | 65                                 | 65                                 |
| Pre-retirement Decrement       | None                               | None                               |
| $a_{65}^{(12)}$                 | 10.0                               | 9.0                                |
| Cost Method                    | Projected Unit Credit (linear proration) | Entry Age Normal                   |

**Participant Data**

| Age                              | 55                                 | 45                                 |
| Service                          | 15                                 | 10                                 |
| Earnings in 1999                 | $80,000                            | $75,000                            |

**Financial Information**

| Assets at December 31, 1998     | $25,000                            | $50,000                            |
1. (CONTINUED)

The company contributed an amount equal to the normal cost for each plan on January 1, 1999. There were no experience gains or losses in 1999.

On January 1, 2000, the assets of the two plans are merged without changing the plan provisions applicable to each member for service prior to January 1, 2000. For service on and after January 1, 2000, each member will accrue benefits under the terms of Plan A.

The plan sponsor needs your advice to decide on the actuarial cost method to fund the merged plan.

(a) Calculate the accrued liability and normal cost at January 1, 1999 for each plan separately.

(b) Calculate the normal cost of the merged plan on January 1, 2000 using the actuarial assumptions for Plan A and the Frozen Initial Liability cost method.

(c) Describe the difference in the expected pattern of the accrued liability and normal cost, for the merged plan, under the following cost methods:

(i) Projected Unit Credit (linear proration)

(ii) Entry Age Normal

(iii) Frozen Initial Liability

Show all work.
2. (6 points) Your client sponsors a non-contributory defined benefit pension plan.

You are given:

**Plan Provisions**
- Retirement Benefit: 1.5% of final year’s earnings times years of service
- Normal Form of Payment: Life only, payable monthly in advance
- Normal Retirement Age: 65
- Termination Benefit: Accrued pension, deferred to age 65

**Actuarial Assumptions and Methods**
- Interest Rate: 7% per year
- Retirement Age: 65
- Salary Increases: 5% at end of year
- Termination Rates: 10% per year at the end of each of the first three years of service, 0% thereafter
- Other Pre-retirement Decrements: None
- Actuarial Cost Method: Projected Unit Credit
- Asset Method: Market value of assets
- $a_{65}^{(10)}$: 10

**Participant Data:**

<table>
<thead>
<tr>
<th></th>
<th>Employee A</th>
<th>Employee B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of Birth</td>
<td>January 1, 1970</td>
<td>January 1, 1960</td>
</tr>
<tr>
<td>Date of Plan Entry</td>
<td>January 1, 1998</td>
<td>January 1, 1995</td>
</tr>
<tr>
<td>2000 Earnings</td>
<td>$40,000</td>
<td>$60,000</td>
</tr>
<tr>
<td>Termination Date</td>
<td>December 31, 2000</td>
<td>N/A</td>
</tr>
<tr>
<td>2001 Earnings</td>
<td>N/A</td>
<td>$70,000</td>
</tr>
</tbody>
</table>

**Financial Information**

- Market Value of Assets at January 1, 2000: $30,000
- Contribution Made at January 1, 2000: $10,000
- Market Value of Assets at January 1, 2001: $45,000
2. (CONTINUED)

(a) Calculate the accrued liability and normal cost at January 1, 2000.

(b) Calculate the accrued liability and normal cost at January 1, 2001.

(c) Calculate the gains and losses, by source, at January 1, 2001.

Show all work.
3. *(7 points)* You are the consulting actuary for ABC Co. which has a non-contributory defined benefit pension plan for its employees. You are given:

**Plan Provisions**
- Retirement Benefit: 2% of final 3 years’ average salary times years of service
- Normal Form of Payment: Life only, payable at the beginning of the year
- Normal Retirement Age: 65
- Other Ancillary Benefits: None
- Effective Date of Plan: January 1, 1999

**Actuarial Assumptions and Methods**
- Interest Rate: 8% per year
- Salary Scale: 5% at end of year
- Retirement Age: 65
- Pre-retirement Decrement: None
- \( \tilde{a}_{65} \): 10.0
- Actuarial Cost Method: Attained Age Normal (level percent of pay)
- Amortization Method: Initial Unfunded Liability over 15 years, payable in advance

**Plan Participants as of January 1, 2000**

<table>
<thead>
<tr>
<th>Age</th>
<th>Service</th>
<th>Salary</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>25 years</td>
<td>$50,000</td>
</tr>
<tr>
<td>30</td>
<td>5 years</td>
<td>$30,000</td>
</tr>
<tr>
<td>40</td>
<td>None</td>
<td>$30,000</td>
</tr>
</tbody>
</table>

The value of assets at December 31, 1999 was $20,000. ABC contributes the normal cost and the amortization payment at the beginning of each year.

Employees received a 6% pay increase at December 31, 1999.

There were no employee terminations during 1999.

Calculate, by source, the change in the normal cost percentage from January 1, 1999 to January 1, 2000.

Show all work.
4. \hspace{1cm} (5 points) You are the actuary for a non-contributory defined benefit pension plan.

You are given:

**Plan Provisions**
- Retirement Benefit: $50 per month times years of service
- Normal Form of Payment: Life only, payable monthly in advance
- Optional Forms of Payment: Actuarial equivalent
- Normal Retirement Age: 65
- Early Retirement Benefit: Accrued retirement benefit, actuarially reduced from age 65

**Actuarial Assumptions and Method**
- Retirement Age: 65
- Actuarial Cost Method: Entry Age Normal

<table>
<thead>
<tr>
<th>$x$</th>
<th>$D_x$</th>
<th>$N_x$</th>
<th>$N_x^{(12)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>98,900</td>
<td>1,288,900</td>
<td>1,243,500</td>
</tr>
<tr>
<td>56</td>
<td>12,800</td>
<td>142,600</td>
<td>136,800</td>
</tr>
<tr>
<td>60</td>
<td>9,200</td>
<td>97,200</td>
<td>93,000</td>
</tr>
<tr>
<td>65</td>
<td>6,000</td>
<td>58,000</td>
<td>55,300</td>
</tr>
</tbody>
</table>

\[ \ddot{a}_{60.56} = 10.6 \]

**Sole Participant Data**
- Date of Birth: January 1, 1940
- Date of Plan Entry: January 1, 1970
- Spouse’s Date of Birth: January 1, 1944

The sole participant retires on January 1, 2000 and elects a 60% joint and survivor form of payment.

(a) Calculate the participant’s monthly retirement pension.

(b) Determine the experience gain or loss due to the participant’s early retirement.

Show all work.
5. *(4 points)* You are the actuary for a defined benefit pension plan for hourly paid employees.

You are given:

**Plan Provisions**
- Retirement Benefit: $40 per month, per year of service
- Normal Form of Payment: Life only, payable monthly in advance
- Normal Retirement Age: 60
- Early Retirement Benefit: Unreduced pension upon attainment of 30 years of service
- Other Ancillary Benefits: None

**Actuarial Assumptions and Method**
- Interest Rate: 7% per year
- Retirement Age: Earlier of age 60 or 30 years of service
- Number of Hours Worked During a Year: 2080
- Other Pre-retirement Decrement: None
- \( \hat{a}_x^{(12)} = 13 + 0.2(60 - x) \)
- Actuarial Cost Method: Entry Age Normal (level dollar)

**Plan Participants**

<table>
<thead>
<tr>
<th>Employee</th>
<th>Date of Birth</th>
<th>Date of Plan Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>January 1, 1958</td>
<td>January 1, 1985</td>
</tr>
<tr>
<td>Z</td>
<td>January 1, 1951</td>
<td>January 1, 1982</td>
</tr>
</tbody>
</table>

The following changes are effective January 1, 2001:

- Retirement benefit will be $43 per month for all years of service.
- Employees will be required to contribute $0.25 for each hour worked.
- Employees will make an additional contribution of $520 for each year of past service.

Determine the change in the employer normal cost at January 1, 2001 resulting from the plan changes.

Show all work.

**END OF EXAMINATION 8**