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SOCIETY OF ACTUARIES

COURSE 5 SOLUTIONS

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COURSE 5
MORNING SESSION

APPLICATION OF BASIC ACTUARIAL PRINCIPLES

SECTION A-WRITTEN ANSWER

SOLUTIONS

****BEGINNING OF EXAMINATION 5****
MORNING SESSION

Question 1

(a)

- Charge higher premium than for non-par
- Allows the premium to be guaranteed
- Offset premium by paying dividends
- Results in lower net cost of policyholder
- Dividends allowing the sharing of good experience on the block of business, including favorable mortality, interest, lapse and tax experience
- Necessary to compete in their selected market

(b)

- Dividends are set using realistic assumptions
- Desired competitive position
- Ensure that agent and policyholder expectations are realistic in dividends illustrated
- Set to achieve certain funding goals (high premium/high dividend, limited pay)
- Reduce the likelihood that dividends may have to be reduced in the future – this can lead to a loss of confidence in the company

(c)

- Concern that companies will pay insufficient dividends to policyholders
- Concern that companies will pay more dividends than it can afford, thereby endangering solvency
- Ensure equitable distribution of profit to shareholders and policyholders
- Ensure equitable distribution of dividends among policyholders of different generations and classes, whose policies generated the profits
- Ensure that any illustrations shown to prospective or current policyholders are reasonable

Question 2

Rating variables that should be considered include:

Age and Gender

Medical claim costs vary greatly among different age bands, and between males and females. Usually claim data are sorted according to age and gender. Age/gender studies are done every few years to develop age/gender factors. Sometimes age/gender factors are developed for different medical expense categories such as drugs or hospital. Also, age/gender factors may take into account the medical plan design such as deductible and coinsurance. Each method for determining exposure units is subject to different types of misestimating of claims costs.

Plan of Benefits

Claim costs are related to the plan itself. Factors such as coinsurance, deductible, maximum limits, tightness of exclusions, out of pocket benefits, and managed care features greatly affect claim costs. Cost-sharing stipulated by different plan designs greatly affects claim costs and must be taken into account. Different plan designs result in different utilization patterns. When plan has choices, employees choose the benefits that are most advantageous to them (= anti-selection).

Geographic Area

Costs of medical services supplied in different geographic areas vary considerably. Medical services in some areas/cities considered expensive compared to others. Thus, geographic area factors should be developed. These factors may also be developed for separate claim incurrals that vary by month of year. Also, it is important to make sure that claims belong to the intended exposure units during the study (1 year) duration.

Trend

The trend (usually an increase in claim costs with time) must be reflected because current claim costs will not be used in the current time, but in the future. Future medical expense costs may change from the current time for several reasons including changes in medical practices, use of new drugs, future technological developments, increases due to inflation. Thus, current claim costs need to be trended toward the future taking into consideration all factors that may affect costs.

Question 3

(a)

Residual Disability Income Benefit

- Also referred to as partial disability income benefit
- Residual disability is more common than total disability
- Residual disability is subjective and difficult to establish
- Encourages return to work or rehabilitation

- Typical Definition: Because of injury or illness,
  - 1A) Person unable to perform important duties of his/her occupation, but able to perform some of them
  - or B) Person is engaged in another occupation
  - 2) Person's monthly earnings after disability are more than 20% and less than 80% of earnings before disability
  - 3) Person is under the care of a physician

- Policies usually require a qualification period before allowing residual benefit
- May require period of total disability
- Qualification period may be 30, 60 or 90 days
- Some policies have zero-day qualification period
- Premium rate higher for shorter qualification period
- May limit benefit period if disability starts after age 60.
- Typical monthly benefit = Monthly Total Disability Benefit $\times$ (A-B)/A
- Where A = Earnings before disability, B = Earnings for month in which benefits are being claimed (reduced earnings)

- May index prior earnings
- Combats effects of inflation
- May be sold in combination with cost-of-living benefit

(b)

Guaranteed Insurability Option

- Insured is given the chance to make periodic increases to monthly benefit as long as he/she is not disabled without medical underwriting
- There is a maximum benefit increase on each option
- Typically maximum number of options allowed (5)
- Options scheduled at yearly intervals
- Sometimes maximum benefit increases are limited to 1 or 2 times the original benefit
- Benefit increases must be evidenced by person's income increase. Require earned income statement from employer. Want to ensure benefits are within participation limits.
- Helps control anti-selection in addition to set option dates and enrollment period

(c)

Cost of Living Benefit

- Benefits increase automatically each year while disabled
- Inflation is the main reason behind this benefit. It aims at keeping the benefit adequate, especially when the disability continues for a long time
- Most of the time this benefit is sold as a separate rider.
- First increase after the first year of disability
- Benefit will be increased by a flat amount, percent compounded, or simple percent each year
- Can be connected to consumer price index
- When CPI used, there may be a maximum and minimum on the percentage increases
- Cost of living can be available with or without caps (typically max increase = 2-3 times of base benefit)

Question 4

70% replacement ratio means retirement benefit should be 70% of final salary.

70%(162,624) = 113,836.80

Components of retirement benefit are:

1) Social Security = 11,700
2) Personal savings (annual amount)
3) Employer sponsored plan

Need to calculate (2), then subtract (1) and (2) from 113,836.80 to get personal savings.

To calculate (2):

$$FAS = \left(S_{64} + S_{63} + S_{62} + S_{61} + S_{60}\right)/5$$

$$= 162{,}624 \times \left(1 + v + v^2 + v^3 + v^4\right)/5, \text{where } v = 1/1.03$$

$$= 153{,}422.68$$

Bn = FAS $\times$ years service $\times$ 1%

$$= .01 \times 153{,}422.68 \times (65 - 30)$$

$$= 53{,}697.94$$

So annual personal savings needs to be 113,836.80 - 11,700.00 – 53,697.94 = 48,438.86

To get this amount annually, the lump sum needed at 65 is:

Annual amount $\times$ annuity conversion factor at 65 =

48,438.86 $\times$ 8.1958 = 396,995.20

To accumulate 396,995.20 at age 65, you need to contribute (at the beginning of each year), where x is the % of salary each year:

$$80{,}000x\left[\left((1.07^{25} + (1.03)(1.07^{24}) + \ldots + (1.03^{24})(1.07)\right)\right] =$$

$$80{,}000x(1.07^{25})\left[1 + 1.03/1.07 + \ldots + (1.03/1.07)^{24}\right] =$$

$$80{,}000x(1.07^{25})\left[1 - (1.03/1.07)^{25}\right]/\left[1 - (1.03/1.07)\right] =$$

$x = 5.56\%$ Must contribute 5.56% of salary each year to get 70% replacement ratio.

Question 5

(a)
Simplified net premium method is a prospective reserve method. It has the following assumptions.

1) death is the only decrement.
2) only include a death and endowment benefit
3) very conservative mortality and interest rate assumptions (prescribed by regulators)
4) death is assumed to happen at the end of the year or evenly distributed throughout the year
5) use formulas to get acquisition costs
6) don't include maintenance expense
7) net premium $= \frac{PVFB(0)}{FVFP(0)} \times$ gross premium
   net premium is used in calculation
8) include for acquisition costs: net level, fully preliminary term, Zillmer

(b)
Realistic net premium method is similar to (a), but include lapse and surrenders, surrender benefit and maintenance expenses.

It also uses a more realistic assumption, more conservative than pricing. Some assumptions may not be as refined as the pricing assumptions because:

1) Reserve is self-corrective (starts & ends at zero)
2) If the error has the similar effect on all policy years, then little effect on reserve
   - acquisition expenses specified by formula

$$\text{net premium ratio} = \frac{FVFB(0) + FVFE(0)}{FVFP(0)}$$

(c)
Gross premium method is similar to (b), but use 1 (one) as net premium ratio. It up-fronts profits at issue if use realistic assumption.
Usually use realistic assumptions with PAD (provision for adverse deviation) dictated by regulation.
If no PAD, called gross premium valuation

- actual acquisition expenses not considered

The above three are all prospective methods.

Reserve(t) = PVFB(t) + PVFE(t) – Net Premium Ratio $\times$ PV of gross premium (t).

(d)
Accumulation method is a retrospective reserve method. It is used when future premium and benefits are not certain. It's used often for dynamic products with flexible premium. The account value is usually used as solvency and earning reserves.
Account value for solvency reserve if:

1) future guaranteed interest rate is not greater than valuation rate
2) future guaranteed COI charge is not greater than future death claims according to valuation mortality
3) future expense is not great than future expense charges.

DAC asset calculated and capitalized to amortize acquisition costs.

Question 6

Entry age = 40

Benefit at 65 = 2% $\times$ 25,000 $\times \left(1.05^{19} + 1.05^{18} + 1.05^{17}\right) \times \frac{1}{3} \times 25 = 30{,}107 = B_{65}$

$$NC_{40} \times \frac{{}^{s}N_{40} - {}^{s}N_{65}}{{}^{s}D_{40}} = B_{65} \times \frac{D_{65}}{D_{40}} \times \ddot{a}_{65}^{(12)}$$

$$NC_{40} = \frac{30107 \times \frac{50}{245} \times 10}{\left(\frac{7100}{245 \times 1}\right)} = 2{,}120$$

$$NC_{45} = 2120 \times \frac{S_{45}}{S_{40}} = 2120 \times 1.05^{5} = 2706$$

Total Normal Cost @ 1/1/2001 = 2706 $\times$ 10 participants = 27,060

Supplemental Liability = Actuarial Liability @ age 45 – Assets

- since Assets = 0, Supplemental Liability = Actuarial Liability

$$AL_{45} = PV_{45}B_{65} - PV_{45}NC_{45}$$

$$= 30{,}107 \times \frac{D_{65}}{D_{45}} \times \ddot{a}_{65}^{(12)} - 2706 \times \frac{{}^{s}N_{45} - {}^{s}N_{65}}{{}^{s}D_{45}}$$

$$= 24{,}736 \quad \left(\text{since } {}^{S}D_{45} = D_{45} \times 1.05^{5}\right)$$

Supplemental Cost $= \frac{24{,}736}{\ddot{a}_{10}} \times 10 \text{ participants} = \frac{24{,}736 \times 10}{7} = 35{,}337$

Annual Cost for Plan at 1/1/2001 $= 27{,}060 + 35{,}337 = 62{,}397$

Annual Cost for Plan at 12/31/2001 = 62,397 $\times$ 1.08 = 67,389

Question 7

1) Driving Force Behind the Product
- Get idea from inside and outside the company
- Compare company's current products
- Assess in light of company weakness and strength
- Determine service and cost and benefits
- Calculate expected profit

2) External Product Driving Force

Planholder
- employer wants good product to attract employee and meanwhile meant to control their cost

Agent/bank/broker/consultant
- They want competitive product, otherwise they will sell other competitors' product
- Also want good compensation

Direct Marketing
- Do market research to find out customer need
- Do survey to find unmet need
- Focus on groups to test new products' competitiveness and weakness

Regulator
- Need to reflect regulation specifics in product feature and rates

3) Internal Company Product Driving Force

Group sales office
- Agent can tell you what product currently missing and information of competitors
- Need good compensation
- Also need sales commitment of sales force office

Home office staff
- Consider strength of the company
- Could try to meet perceived market needs
- Could adjust product to best profitability, reduce risk or just keep competitive
- Unique products feature can help sell the product at higher premium

4) Evaluating the Experience
- Know the competition, know the products' unique features, know the administrative rules and underwriting rules
- Get experience data
- Find out what market is best for the product

5) Product Company Fit
- If product fits target market, could be a quick success; otherwise need to find new market
- Assure administrative system can support the product
- Ascertain structure of benefit payment and incentive structure

- Effect of tax (reserve, premiums, benefit, imputed income)

6) Clarifying the Product
   - Determine target market
   - Determine administrative rules and cost
   - Training the company staff
   - Profit could be subject to underwriting cycle
   - Use reinsurance to increase risk capacity, smooth fluctuations and design product

7) Expected Profit
   Could use lower profit margin if can:
   - Get more sales
   - Amortize more fixed expenses
   - Less risky
   - Lower required capital
   - Keep core competitiveness

****END OF WRITTEN ANSWER SECTION****

COURSE 5
AFTERNOON SESSION

APPLICATION OF BASIC ACTUARIAL PRINCIPLES

SECTION C-WRITTEN ANSWER

SOLUTIONS

****BEGINNING OF EXAMINATION 5****
AFTERNOON SESSION

Question 8

(a)
Reasons:

1) To stay below retention limit
2) Use facultative reinsurance to underwrite the case with uncertainty about the risk
3) Partner with reinsurance to enter into new business line or products
4) Sell the product which the field force wants but the company does not desire
5) Manage taxes. Can substantially use reinsurance to produce given to offset previous losses
6) To smooth out fluctuation in earning
7) Leverage the business if the reinsurance required rate of return is lower than the company's
8) If reinsurance rate is lower than ceding company rate, profitable to reinsurance
9) Use reinsurance to enhance capital in order to write new business (financial reinsurance)
10) Use expertise of reinsurance in lieu of underwriting, products design, avoid compensation limit, fronting reinsurance

(b)
(i)
Total quote share = 24% + 36% = 60%
Retain = 100% - 60% = 40%
$\therefore$ Retain Amount = (\$1,200,000 - \$100,000) $\times$ 40% = \$440,000

(ii)
Amount ceded to Alpha Life = (\$1,200,000 - \$100,000) $\times$ 24% = \$264,000

(iii)
Amount ceded to Beta Life = (\$1,200,000 - \$100,000) $\times$ 36% = \$396,000

Question 9

(a)
Underwriting large group life insurance plans considerations

- claims are high severity and low frequency
- exposed to anti-selection when employees are given a choice of benefit (e.g. optional life); can offset by higher participation rates.
- Need underwriting or evidence of insurability for larger face amount (especially above non-medical amount)
- Consider new benefit developed
    - living benefits: if terminal illness
    - problem if recovery
    - Group Universal Life
- also need underwriting for late enrollees/entrants
- alternative funding arrangements may be limited since it may lose the tax advantages of benefit paid to beneficiary
- allow employee only to choose the amount of benefit restricted to multiple of earnings
- also restrict the employee to change their option only by the end of every year
- more DC cafeteria plans are used

(b)
Major considerations involved in underwriting large group disability

- Again, disability claims are volatile (high claims and low frequency)
- Rates vary by age, sex, industry/occupation and economic conditions
- Replacement ratio vary by occupation of level of benefits
- Need to integrate with social security benefit
- Should avoid to have total disability greater than pre-disability; for example:
  (i) If replacement ratio is >50%, should reduce percentage of total benefit paid
  (ii) May be to reduce the benefit by integrating with social security benefit
- Restrict the liberal definition of disability
    - May only limit the use of "own occupation" definition to white/professional group
- Need healthy, financial group/company
    - Therefore get commercial rating of the company regarding their financial strength
- Avoid companies that are overstaffed (since don't want to use disability benefits for unemployment)
- Avoid situation where layoffs are expected or company where there are high turnovers or seasonal workers
- Union is the worst; should avoid,
    - But still need to help the union help control cost
    - Is the union keeping good records of administration?
- Non-contributory group plan is the best (limited to anti-selection)

- Need to estimate earnings for commissioned sales (normally use last 12 month earnings); however, since earnings = sale commission, creates problems, e.g. when are they becoming disabled
- Disability claims seem to come in cycles; therefore, should save surplus in the good time
- Better to have tighter underwriting than increased rate

(c)

Past Experience Data

- Group life insurance
- Low frequency and high severity…volatility
- Need several years of experience
- Need to pool large experience of claims

(d)

Group Disability Income Plans

- Low frequency and high severity…volatility
- Need several years of experience
- Need to do large claims pooling
- Also need to validate the disability reserve

Question 10

(a)
United States
- Employer contributions are tax deductible to employer
- Employer contributions are not taxable income to employee
- Benefits received are not taxable
- Employee contributions are not tax deductible

Canada
- Benefits received are not taxable
- Private plan employer contributions are tax deductible
- Private plan employee contributions are not tax deductible

(b)
United States
- Employer contributions are tax deductible
- Employee contributions are not tax deductible
- There is imputed income on coverage over 50,000
    - Take amount over 50,000, multiply by Table I factor, then subtract employee contributions
- If discriminatory plan, then key people have imputed income on all coverage
- Benefits received are not taxable

Canada
- Employer contributions are tax deductible
- Employee contributions are not tax deductible
- Imputed income to employee on amounts
- Benefits received are generally tax free

(c)
United States
- Benefits received are taxable to extent employer paid contribution
- Typically either all employer or all employee paid contributions

Canada
- Benefits received are taxable income

Question 11

(a)
Income Annuities
1) Mortality Assumptions – Important because of:
- Anti-selection (healthiest lives only want coverage)
- Mortality improvements (since life expectancy up, income annuities are more expensive)
- Longevity risk (consistent with higher cost from longer life)

2) Dangers Interest Rate/Investment Income Dangers – very important (most important)
- Guaranteeing high interest rates without investing properly
- Disintermediation risk if back short term assets with long term liabilities (e.g., the annuity has a SU with no SC)

- Ways to Protect
    - For single premium income annuities (most common), match assets to liabilities
    - For short term, volatile cash flows make sure assets are short term

- Also Consider
    - Balance risk with competitive product (need to keep customer happy, but survive too)
    - Also consider default risk (if backing liabilities with risky assets to try and get a higher return)

3) Expenses
- Small risks – have to consider average premium and sales volatility
- Ongoing Assumptions:
    - valuations
    - make sure annuitant is still alive
    - cost of making payment (e.g. check)

4) Lapses, Surrenders
- These are very, very rare in income annuities. If you did offer surrenders, there would be huge anti-selection (people on death row would surrender!)

(b)
Accumulation Annuities
1) Mortality assumption – not too important
- Have to consider more closely if there is a guaranteed minimum Death Benefit

2) Investment Income/Interest Rate
- For deferred annuities, have to consider the spread (earned-credited) rate.
- There will be a lag in the amount (credited) paid by 1 period

Variable Annuities

- Mostly risk of lower charge (because it's a percent of the asset value), but if bad investment income:
    - less profits (less asset value charges)
    - could cause lapses because policyholder upset or even had dried up the account!

3) Expenses – same average premium and sales volatility to consider

- Also ongoing expenses with accumulation annuities
- Tracking commissions on flexible product
- Customer inquiries
- Processing surrenders, authorizations, policy loans, etc.
- Producing periodic reports to show to policyholder

4) Surrender/Lapses

- Factors that have high surrenders/lapses:
    - no surrender charge
    - younger issue age
    - market interest rate is bigger than crediting rate

5) Premium Payment Pattern

- Will depend on:
    - purpose of product
    - resources of buyers
    - tax treatment (huge importance)

6) Annuitization

- Very important for guaranteed minimum income bracket and two-tiered annuities
- Could track only profit/loss resulting from annuitizations in pricing, or
- Could track all features of each product over its lifetime

Question 12

(a)
Traditional Unit Credit
Benefit payable at normal retirement = b_x based on plan provisions service and salaries to date

Normal cost = Present value of benefits earned over the next year
$(b_{x+1} - b_x) \times \ddot{a}_R^{(12)} \; v^{R-x} \; {}_{(r-x)}P_x$
difference between next year's benefit and this year's benefit

Accrued Liability = $b_x \times \ddot{a}_R^{(12)} \times v^{R-x} \times {}_{(R-x)}P_x^{(T)}$
$b_x =$ benefit earned as of age x payable commencing at age R
$\ddot{a}_R^{(12)}$ Present Value at Age R of monthly annuity commencing at age R
$v^{R-x} = \left(\frac{1}{1+i}\right)^{R-x}$ – discount for interest from age R to age x

${}_{(R-x)}P_x^{(T)} =$ probability of surviving and staying in plan from age x to age R

Accrued liability is the present value of the benefit accrued to date = PV (accrued benefit)

Normal cost is the Present Value of the additional benefit that will be earned over the coming year

(b)
Projected Accrued Benefit
$B_R =$ Projected benefit at retirement including all years of service and future benefit increases

Accrued Liability = Present value as of age x of projected benefit at retirement
Prorated by service at age x /service at age R
= PV (Projected Benefit) $\times \; \frac{\text{current service}}{\text{total service}}$

Projected unit credit reflects the effect of future salary increases on the benefit earned to date.

Question 13

(a)

Step 1: Determine new average rate

Loss cost = $\dfrac{\text{losses, trended \& developed}}{\text{units of earned exposure}}$

New Average Rate = $\dfrac{\text{Loss cost}}{\text{Permissable loss ratio}}$

Loss Cost = $\dfrac{1{,}100{,}000 + 1{,}200{,}000 + 400{,}000}{50{,}000 + 30{,}000 + 20{,}000} = \dfrac{2{,}700{,}000}{100{,}000} = 27$

New Average Rate = $\dfrac{27}{0.6} = 45$

Old Average Rate = $\dfrac{(40)(50{,}000) + (50)(30{,}000) + (75)(20{,}000)}{100{,}000} = 50$

$\therefore \textit{Average rate}\,\Delta = \dfrac{45}{50} - 1 = -10\%$

Step 2: Change differentials

$\text{Indicated differential}_i = \dfrac{LC_i}{LC_{base}}$

Use class A as base (largest exposure)

$LC_A = 1{,}100{,}000 / 50{,}000 = 22$
$LC_B = 1{,}200{,}000 / 30{,}000 = 40$
$LC_C = 400{,}000 / 20{,}000 = 20$

$\text{Ind Diff}_B = 40 / 22 = 1.82$
$\text{Ind Diff}_C = 20 / 22 = 0.91$

Step 3: Balance back

$$\text{Off-balance factor} = \frac{\text{Proposed average differential}}{\text{Existing average differential}}$$

$$\text{Off-Balance factor} = \frac{(1)(50{,}000)+(1.82)(30{,}000)+(0.91)(20{,}000)}{(1)(50{,}000)+\left(\frac{50}{40}\right)(30{,}000)+\left(\frac{75}{40}\right)(20{,}000)}$$

$$= \frac{122{,}800}{125{,}000} = 0.9824$$

$$\text{Final base rate (class A)} = (40)(1-10\%)\left(\frac{1}{0.9824}\right) = 36.64$$

$$\text{Class B rate} = (36.64)(1.82) = 66.69$$

$$\text{Class C rate} = (36.64)(0.91) = 33.34$$

$$\text{Double check: new average rate} = \frac{(36.64)(50{,}000)+(66.69)(30{,}000)+(33.34)(20{,}000)}{100{,}000} = 45$$

(b)

Step 1: Determine new average rate

$$\text{Loss ratio} = \frac{\$\text{losses, trended \& developed}}{\$\text{premiums @ current rates}}$$

$$\text{Indicated rate } \Delta = \frac{\text{loss ratio}}{\text{permissable loss ratio}} - 1$$

Loss ratio

$$= \frac{1{,}100{,}000+1{,}200{,}000+400{,}000+2{,}600{,}000+2{,}640{,}000+2{,}400{,}000}{(40)(50{,}000)+(50)(30{,}000)+(75)(20{,}000)+(80)(60{,}000)+(100)(40{,}000)+(150)(20{,}000)}$$

$$= \frac{10{,}340{,}000}{16{,}800{,}000}$$

$= 0.6155$

Indicated rate $\Delta = \frac{0.6155}{0.6} - 1 = 2.58\%$

Step 2: Change differentials

$$\text{Indicated differential}_i = \textit{existing differential}_i \times \frac{LR_i}{LR_{base}}$$

Assume territory 2 is base territory (largest exposure)

$$LR_2 = \frac{2{,}640{,}000 + 2{,}600{,}000 + 2{,}400{,}000}{(80)(60{,}000) + (100)(40{,}000) + (150)(20{,}000)}$$

$$= \frac{7{,}640{,}000}{11{,}800{,}000} = 0.6475$$

$$LR_1 = \frac{1{,}100{,}000 + 1{,}200{,}000 + 400{,}000}{(40)(50{,}000) + (50)(30{,}000) + (75)(20{,}000)}$$

$$= \frac{2{,}700{,}000}{5{,}000{,}000} = 0.54$$

$$\text{Indicated differential}_i = (0.5)\left(\frac{0.54}{0.6475}\right) = 0.417$$

Step 3: Balance back

Off Balance factor =

$$\frac{(1)(60{,}000) + \left(\frac{100}{80}\right)(40{,}000) + \left(\frac{150}{80}\right)(20{,}000) + (.417)(50{,}000) + (.417)\left(\frac{100}{80}\right)(30{,}000) + (.417)\left(\frac{150}{80}\right)(20{,}000)}{(1)(60{,}000) + \left(\frac{100}{80}\right)(40{,}000) + \left(\frac{150}{80}\right)(20{,}000) + (.5)(50{,}000) + (.5)\left(\frac{100}{80}\right)(30{,}000) + (.5)\left(\frac{150}{80}\right)(20{,}000)}$$

$$= \frac{199{,}625}{210{,}000} = 0.9506$$

Final balance rate (Territory 2, Class A): $(80)(1.0258)\left(\frac{1}{0.9506}\right) = 86.33$

Territory 2, Class B rate = $(86.33)\left(\frac{100}{80}\right) = 107.91$

Territory 2, Class C rate = $(86.33)\left(\frac{150}{80}\right) = 161.87$

Territory 1, Class A rate = $(86.33)(0.417) = 36.00$

Territory 1, Class B rate = $(86.33)(0.417)\left(\frac{100}{80}\right) = 45.00$

Territory 1, Class C rate = $(86.33)(0.417)\left(\frac{150}{80}\right) = 67.50$

Double check: new average rate = $\frac{17,233,600}{220,000} = 78.33$

Old Average Rate = $\frac{16,800,000}{220,000} = 76.36$

Average rate $\Delta = 2.575\%$

Question 14

Required capital is the target or minimum level of capital needed by a company. It is the amount of capital a company needs to withstand reasonable fluctuations in results.

Risks covered in required capital calculation:

1) Asset Default Risk
   - Asset default risk is the risk that an asset permanently loses value.
     - When this occurs the company must reduce the value of the asset shown on its books.
     - This directly reduces capital and may reduce earnings.
     - There may be different default risk factors for different type of assets and for different categories within an asset type.

2) Insurance Risk
   - Insurance risk is primarily the risk that mortality or morbidity experience exceeds to the levels anticipated in pricing
     - Can result from random fluctuations or incorrect assumptions used in pricing
     - Random fluctuations usually become less significant as the size of the company increases
     - This risk may also include the risk of pricing assumptions for persistency, expenses and investment income

3) Interest Rate Risk
   a) Disintermediation Risk
   - Risk of having to sell assets at a loss to fund substantial cash outflows

   b) Guarantee Risk
   - Risk that the interest rate guaranteed in a product exceed the interest rates earned on investments

   c) Liquidity Risk
   - Risk that assets cannot be sold fast enough to cover cash demands on liabilities.
   - Important for life insurance companies because most liabilities are payable on demand and most assets are invested long term.

4) Interest Spread Risk
   - The risk of insufficient interest spreads due to investment and pricing decisions
   - May be due to one or more of the following:
     - Coordination problem between investment, pricing and administration areas
     - Insufficient availability of investment opportunities
     - Similar competing products offer attractive crediting rates

5) Other Risks
These include:
- Mispriced products
- Lawsuits
- Changes in tax laws
- Adverse publicity
- Change in regulations

****END OF COURSE 5 EXAMINATION****
AFTERNOON SESSION