IAQS | INSTITUTE OF ACTUARIAL & QUANTITATIVE STUDIES

Subject: SRM - 1

Chapter: Unit 3 & 4

Category: Assignment Questions

Unit 3 CH 1

1. A medium size Indian Life insurance company has taken up the project of mortality investigation in respect of its term assurance product for the purpose of assessing the feasibility of premium rates. The student actuary obtained the following age band wise data:

Age band	E_x^c	d_x	Crude rate $\mu_{x+1/2}$	Graduated rate $\mu^o_{x+1/2}$	z_x
18-22	1388.90	10	0.0072	0.0061	0.5249
23-27	1188.80	17	0.0143	0.0131	0.3615
28-32	880.50	28	0.0318	0.0262	1.0266
33-37	841.60	34	0.0404	0.0487	-1.0912
38-42	402.80	41	0.1018	0.0839	1.2394
43-47	123.90	19	0.1533	0.1338	0.5949
48-52	27.90	7	0.2509	0.1975	0.6346
53-57	10.00	3	0.3000	0.2706	0.1787
58+	7.50	2	0.2666	0.3455	-0.03673

a) Explain why the crude rates calculated above may not be suitable for the purpose. (4)
b) Test the performed graduation for overall goodness of fit and smoothness. (4) [8]

Unit 3 CH 2

2. A large life insurance company has been selling term assurance plan for a number of years and has carried out a mortality investigation for the first time recently. Mr. Bimankak, the company's Appointed Actuary is generally satisfied with the results and has recommended that the mortality rates obtained be used for setting mortality assumptions in the future. However, Mr. Bimankak has also suggested that the crude rates from the investigation are 'smoothed' before using them in actuarial calculations. He has sought your opinion on the appropriate method for graduation. Briefly describe three methods of graduation that can be used, stating clearly the advantages and disadvantages of each as relevant to the insurance company. [9]

Unit 3 CH 2

3. i) List the methods of graduation. Describe how smoothness is ensured when mortality rates are graduated using each method? (3)

ii) Explain why a mortality experience would need to be graduated. (2)

Unit 3 CH 2

3.An actuary has conducted investigations into the mortality of the following classes of lives:

I. Members covered under PMJJY (Pradhan Mantri Jeevan Jyoti Bima Yojana)

II. Female population of a large developing country

The actuary wishes to graduate the crude rates for each of the above classes of lives

iii) State an appropriate method of graduation with rationale for each of the two classes of lives and, for each class, briefly explain your choice. (3)

A large life insurance company has graduated the mortality experience of a business portfolio. The original data and the graduated rates are as follows

Age	Exposed to risk	Number of deaths	Graduated Rates
50	1280	4	0.00230
51	2030	5	0.00262
52	1950	11	0.00296
53	2160	7	0.00331
54	2480	10	0.0037
55	1455	7	0.00415
56	2100	11	0.00463
57	1865	17	0.00518
58	1990	16	0.00578
59	1725	9	0.00645

iv) Test the graduation for overall goodness of fit. (4) [12]

Unit 3 CH 1

4. As part of the exercise to price a group insurance scheme, a large Life Insurance Company has undertaken to investigate the mortality rate of the employees engaged in a hazardous occupation. The following is an extract from the exercise.

It was decided to graduate results with reference to the standard mortality rate of an assurance table published by the actuarial institute using a formula

$$\overset{o}{q}_x = 2 * q_x^s .$$

The q_x^s is the standard mortality rate. The standard mortality rates from the assurance table for the average ages are given below:

Age	23	28	33	38	43	48	53	58
Mortality rate	0.0011	0.0012	0.0013	0.0018	0.0027	0.0045	0.0075	0.0115

(i) Explain the terms "Under Graduation" and "Over Graduation". (2)

(ii) Using a test of the overall fit of the graduated rates to the data, test the hypothesis that the observed mortality rates are in accordance with the graduated rates as per the formula given above. (6)

(iii) Test the graduation using two other tests i.e. signs test and grouping of signs test. For each test:
(a) State the feature of the graduation it is designed to detect.
(b) Carry out the test.
(c) State your conclusion. (6) [14]

Unit 4

5. State the two factor Lee-Carter model. Define all the parameters and state the two constraints used while estimation. [5]

Unit 3 CH 1

6. A life insurance company proposes to graduate the crude estimates obtained from its investigations before using them for determining premiums.

i) Graduation is said to resolve the conflicting requirements of smoothness and adherence to data. Explain: a) how this conflict arises, and b) how the process of graduation resolves the conflict (4)

Unit 3 CH 1

7. i) Explain what is meant by graduation and the aims of graduation (2)

ii) Explain the three desirable features of graduation (1)

iii) Describe what is meant by 'over-graduation' and 'under-graduation' (2)

iv) In one of the mortality studies, the crude mortality rates have been fitted by using the below equation

$$q_x = A \exp(-B * x) + \frac{CD^x}{1 + CD^x}$$

Where q_x is the probability of a person aged x dying before age x+1 and A, B, C, D are parameters that were estimated by least squares.

The parameters were estimated separately for males and females and are as given below

Parameter	Male	Female
A	0.00119	0.00012
B	0.86895	1.83524
C	0.00012	0.00007
D	1.08145	1.08175

Below are the crude mortality rates observed at certain ages

Age	Male	Female
20	0.00569	0.00337
25	0.00794	0.00468
28	0.01106	0.00651
33	0.01541	0.00904
66	0.02151	0.01255
71	0.02998	0.01744

For the above ages, derive the graduated rates using the formula given above (4)

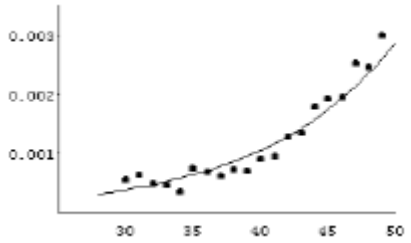
v) Perform an overall test of the graduation process and comment on the appropriateness of the graduation. (3) [12]

Unit 4

8. How is mortality projected by the expectation method?

Unit 3 CH 1

9. i) Define the type of graduation in the figure below: (1)



ii) How do you test smoothness while performing graduation? (3)

iii) State the disadvantages of the Chi-Square test as a test of a mortality experience. (3)

iv) List one test that does not require making any assumption while testing for mortality experience. (1) [8]