

POST-GRADUATE DIPLOMA IN ACTUARIAL SCIENCE

Introduction:

Actuaries are statisticians involved in number crunching and handling tons of mortality and other statistics to device the correct pricing of insurance policies. As an actuary, he has the opportunity to work in a wide number of areas in life insurance, general insurance, reinsurance, pension funds, risk management and so on. The work profile includes product design, policy pricing and asset-liability management among others.

The Insurance Regulatory and Development Authority (IRDA) mandates that life insurance companies must have at least one appointed actuary, while general insurers can meet their actual needs with the help of consultants. Over the next three years, industry sources expect the number of actuaries in private sector life insurance to double. Consultants feel that over five years, the number can reach 600 in life and about 300 in non life insurance. Demand for actuaries is likely to intensify as new entrants look at India and some expatriates in existing companies return home. While the opportunities for young, experienced students is currently good, long-term demand will come at the experienced, senior, appointed actuary level.

Fee Structure:

Rs. 40,000 per year *

Rs. 1,000 Examination fee per term.

Rs. 800 P.G. Registration Fee.

***Note:** If there is a change in the fees then the excess amount will be collected afterwards.

Scheme of Examination:

The evaluation of the performance of a student in each paper shall be based

upon both internal assessment and external examination. The external examination will be held only once at the end of an academic term. The external examination will consist of EIGHT papers each of THREE hours.

Subject	Title	Internal	External	Total
Paper I	Financial Mathematics	40	60	100
Paper II	Finance and Financial Reporting	40	60	100
Paper III	Probability and Mathematical Statistics	40	60	100
Paper IV	Business Economics	40	60	100

Paper V	Contingencies	40	60	100
Paper VI	Statistical Methods	40	60	100
Paper VII	Statistical Models	40	60	100
Paper VIII	Finance and Statistical Economics	40	60	100

First term will consist of first four papers & Second term will consist of next four papers.

Internal Exam will be held only once in each term.

Paper –I: FINANCIAL MATHEMATICS

1. Interest rates and factors
2. Level annuities
3. Varying annuities
4. Non-annual interest rates and annuities
5. Project appraisal and loans
6. Financial instruments
7. Duration, convexity and immunization
8. The term structure of interest rates
9. Stochastic interest rates

Reference Books:

1. Baxter, Robert. Finance Mathematics, Medford, OR: Baxter
2. Hart, W. L. Mathematics of Investment, Lexington, MA: D.C. Health, 1975, Fifth edition.
Instructional Materials, 1992. Sixth Edition Revised and Expanded.
3. Karatzas, Ioannis and Shreve, Steven E., Methods of Mathematical Finance, New York, NY: Springer, 1998.
4. Kellison, Stephen G. The theory of Interest, Homewood, IL: Richard D. Irwin, 1970, 1990. Second Edition.
5. Martin, Peter G. and Burrow, Michael. Applied Financial Mathematics, New York, NY; Sydney: Prentice Hall, 1991.
6. McCutcheon, J. J. and Scott, W. F. An Introduction to Mathematics of Finance
7. Roman, Steven. The Mathematics of Finance, Irvine, CA: Innovative Textbooks, 1993.
8. Ruckman Chris & Francis Joe : Financial Mathematics : A practical guide for Actuaries and other Business professionals
9. UK Institute of Actuaries core reading for the subject CT1 financial mathematics
10. Watsham, Terry J. and Parramore, Keith. Quantitative Methods in Finance, London; Boston, MA: International Thomson Business Press, 1997. First Edition.

Paper-II: FINANCE AND FINANCIAL REPORTING

1. Key principles of finance
2. The basic construction of accounts of different types and principal features of the accounts of company
3. Interpretation of the accounts of a company or a group of companies and limitations of such interpretation
4. The characteristics of the principal form of financial instrument used by companies
5. Definition of company's cost of capital and weighted average cost of capital
6. Factors to be considered by company when deciding on its capital structure and dividend policy
7. Financial techniques used in the assessment of capital investment project
8. Definitions & Residential Status under Income Tax Act, 1961
9. Heads of Income under Income Tax Act, 1961
10. Basic principles of personal taxation under Income Tax Act, 1961
11. Basic principles of company taxation under Income Tax Act, 1961

Reference Books

Foreign Authors

1. Brealey, Richard A and Myers, Stewart C, principles of corporate finance.
2. Brigham, Eugene F Houston, Joel F, Fundamentals of financial management
3. Holmes, Geoffrey and Sugden, Alan, interpreting company reports and accounts
4. Samuels, J.M.; Wilkes, F.M; Bray Shaw, R.E. management of company
5. UK Institute of Actuaries Core Reading for subject CT2 Finance and Financial Reporting

Indian Authors

1. Advanced Accountancy – S.N. Maheshwari ISBN 0706999118
2. Advanced Accounts – M.C. Shukla, T.S. Grewal
3. Financial Accounting – P.C. Tulsian
4. Financial Management – M.Y. Khan, P.K. Jain ISBN 9780070656147
5. Financial Management – Prasanna Chandra ISBN 9780070656659
6. T.N. Manoharan – Tax
7. Vinod Singhania – Tax

Paper III: PROBABILITY AND MATHEMATICAL STATISTICS

1. Main features of a data set (exploratory data analysis)
2. Concepts of probability
3. Concepts of random variable, probability distribution, distribution function, expected value, variance and higher moments
4. Probability generating function, moment generating function, cumulant generating function and cumulant.

5. Basic discrete and continuous distributions
6. Concept of independence, jointly distributed random variables and conditional distributions, use of generating functions
7. Central limit theorem and its applications
8. Concepts of random sampling, statistical inference and sampling distribution
9. Methods of estimation and properties of estimators
10. Confidence intervals for unknown parameters
11. Testing of hypotheses
12. Correlation and regression analysis
13. Concept of analysis of variance
14. Concepts of conditional expectations and compound distribution

Reference books:

1. Hogg, R., and A. Craig: Introduction to Mathematical Statistics, The Macmillan company, New York, 1959.
Mathematical Statistics with applications, Duxbury, 2002.
2. Mood Alexander M., Graybill Franklin A.:(1950) Introduction to the theory of Statistics Second Edition, McGraw –Hill Book Company Inc.
3. Rohatgi V. K. and A. K. MD. Ehsanes Saleh: An introduction to probability theory abd mathematical statistics, 2nd ed. John Wiley and Sons, 2001.
4. UK Institute of Actuaries core reading for reading for subject CT3
Probability and mathematical Statistics
5. Wackerly D. D; Mendenhall III, and Scheffer, R. L.

Paper IV: BUSINESS ECONOMICS

1. Relevance of economics to the world of business.
2. The workings of competitive markets.
3. Consumer demand and behaviour.
4. Firm's decision on product selection and marketing and advertising strategies.
5. Production function, costs of production, revenue and profit in order to understand a firm's price and output decisions.
6. Profit maximisation under perfect competition ,imperfect competition and monopoly.
7. Role of a firm's growth strategy on its profitability and survival.
8. Pricing strategies that firms can adopt.
9. Reasons for government intervention in the market.
10. Relationship between the government and the individual firm.
11. Globalisation and multinational business.
12. The importance of international trade.
13. The macroeconomic environment of the business.
14. The Balance of payments and concept of exchange rate determination.
15. The role of money and interest rates in the economy.
16. Determinants of level of business activity and how it affects unemployment and inflation.
17. Macroeconomic policies impact on businesses.
18. Supply side policies impact on businesses.

Reference Books:

1. Business economics. Perman, R.; Scouller, J. Oxford University Press, 1999.
2. Economics. Begg, D. K. H.; Fischer, S.; Dornbusch, R. 9th ed. McGraw-Hill, 2008.
3. Economics. Krugman, P.; Wells, R.; Graddy, K. European ed. Worth, 2007.
4. Economics. Lipsey, R. G.; Chrystal, K. A. 11th ed. Oxford University Press, 2007
5. Economics. Mankiw, N.G.; Taylor, M. P. Thomson, 2006
6. Economics. Parkin, M.; Powell, M.; Matthews, K. 7th ed.
7. Economics. Sloman, J. 6th ed. FT Prentice Hall, 2006. ISBN: Pearson Education, 2007.
8. Economics for business. Begg, D. K. H.; Ward, D. 2nd ed. McGraw-Hill, 2007.
9. Essentials of economics. Sloman, J. 4th ed. FT Prentice Hall, 2006.
10. Institute of Actuaries core reading for the subject CT7 economic

Paper V: CONTINGENCIES

1. Simple assurance and annuity contracts
2. Practical methods of evaluating expected values and variances of the simple contracts
3. Life Tables.
4. Variable benefits and annuities.
5. Gross premiums and reserves.
6. Joint life and last survivor status.
7. Multiple decrements.
8. Profit Testing
9. Factors affecting mortality.

Reference Books:

1. Benjamin, Bernard and Pollard, John H., The analysis of mortality and other actuarial statistics. 3rd ed. Institute of Actuaries and Faculty of Actuaries, 1993
2. Booth, P. M. al., Modern actuarial theory and practice, Chapman & Hall, 1999
3. Bowers, Newton L et al., Actuarial Mathematics 2nd ed. Society of Actuaries, 1997.
4. Gerber, H. U., Life insurance mathematics 3rd ed. Springer, Swiss Association of Actuaries, 1997
5. Haberman, S. and Pitacco, E., Actuarial models for disability insurance Chapman & Hall, 1999
6. Life Contingencies – A guide for the Actuarial Student – by Robert W Batten
7. Life Contingencies- by C. W. Jordon (Chester Wallance Jordon)
8. Neill, Alistair, Life contingencies. Heinemann, 1977
9. Theory of Interest and Life Contingencies with Pension Applications: A problem solving approach- by Michael M. Parmenter
10. UK Institute of Actuaries Core Reading for subject CT5 contingencies.

Paper VI: STATISTICAL METHODS

1. Claims Reserving and Pricing with Run-off Triangles
2. Loss Distribution
3. Risk Theory
4. Ruin theory
5. Credibility Theory
6. No claim discounting in Motor Insurance
7. Generalized Linear Model
8. Decision and Game Theory
9. The main concepts underlying the analysis of time series models
10. Concepts of "Monte Carlo" simulation

Reference Books:

1. Bolan Philip J. – Statistical and Probabilistic Methods in Actuarial Science
Chapman and Hall/CRC
2. Box G.E.P. and Jenkin's : Time series analysis forecasting and control
3. Morgan B.J.T. Elements of simulation, Chapman & Hall, 1995.
4. UK Institute of Actuaries core reading for subject CTVI statistical methods
5. Ross S. M. Introduction to Probability Models- 7th Edition
Academic Press/Harcourt 2000

Paper VII: STATISTICAL MODELS

1. Principles of Stochastic Processes, their classification into different types
2. Markov Chains
3. Two state Markov Model
4. General Markov Model
5. Markov Jump Process
6. Survival Models and life tables
7. Estimating lifetime distribution function
8. The Cox regression model
9. The binomial and poison Model
10. Exposed to risk
11. Graduation and Statistical tests
12. Methods of graduation.
13. Ross Models: From Data to decisions (third edition)(2008), Klugman S.A.,
Panjer H.H., and Willmot, G.E.

Reference Books:

1. Bain L. J.: Statistical Analysis of reliability and life testing models
2. Bhat Narayan U. & Miller Gregory K (2002): Elements of applied
Stochastic Processes Third edition, John Wiley and sons
3. Durrett R.: Essentials of Stochastic Processes
4. Kulkarni V. G.: Modelling and analysis of stochastic systems.

5. Medhi J.: Stochastic Processes, Wiley Eastern Ltd, 2nd Edition 1994
6. Ross S. M.: Introduction to Probability Models
7. Smith P. J. : Analysis of failure and Survival data
8. UK Institute of Actuaries core Reading for Subject CT4 Models

Paper VIII: FINANCIAL AND STATISTICAL ECONOMICS

1. Mechanics of Future Market & Hedging Strategies
2. Interest Rate
3. Determination of Forward and Future Prices
4. Interest Rate Futures, Swaps
5. Mechanics of options Markets
6. Properties of Stock Options, Trading Strategies involving options
7. Binomial Trees, Wiener Procedures and Ito's Lemma
8. The Black-Scholes-Metron Model
9. Basic Numerical Procedures, Credit Risk
10. Martingales and Measures, Interest Rate Derivatives: the standard market models

Reference Books:

1. Elton Edwin J. and Gruber Martin J. (1997): Modern Portfolio Theory and Investment analysis 7th edition, John Wiley & Sons
2. Hull John C. (2006): Options, Future and other Derivatives 8th Edition
3. Panjer Hary H. (1998): Financial Economics

Standard of Passing:

1. A candidate securing a minimum of 200 out of 400 marks with a minimum of 40 marks in each of the four papers consisting of internal and external examination taken together will be declared to have passed in that examination.
2. If in a paper a candidate secures minimum of 50% marks consisting of internal and external examination taken together, will be exempted from that paper.
3. A candidate will be declared to have passed the examination if he/she passed in all papers.
4. A candidate will be awarded the following Grades on the basis of percentage of total marks obtained by the candidate in one or more attempt (s).

Percentage	Grade
50 below 60	C
60 below 70	B
70 below 80	A
80-100	A ⁺

5. A registration of the candidate is valid only for three years for the course. After the three years he/she will have to register again.

Entrance Test

Sample Question Paper: PGDASS and PGDAS

1. $x^y = e^{y-x}$ then find $\frac{dy}{dx}$
- (a) $\frac{2 - \log x}{(1 - \log x)^2}$ (b) $\frac{\log x}{(1 - \log x)}$
- (c) $\frac{-\log x}{(1 + \log x)^2}$ (d) $\frac{1}{(1 - \log x)^2}$
2. If $x^4 y^6 = (x + y)^{10}$ then find $\frac{dy}{dx}$
- (a) $\frac{y}{x}$ (b) $\frac{x}{y}$
- (c) xy (d) $\frac{x}{10y}$
3. $\lim_{x \rightarrow 3} \frac{x^3 - 27}{-4 + \sqrt{x^2 + 7}}$
- (a) 36 (b) 0 (c) 63 (d) Limit does not exist
4. $\lim_{x \rightarrow 1} \frac{x + x\sqrt{x} - 2}{x^2 - 1}$
- (a) ∞ (b) $\frac{4}{5}$ (c) $\frac{5}{4}$ (d) 0
5. If $y = x^e + e^x$ then find $\frac{dy}{dx}$
- (a) $ex^{e-1} + xe^{x-1}$ (b) $x^e + e^x$ (c) $ex^{e-1} + e^x$ (d) $ex^{x-1} + \log x$

6. $\lim_{x \rightarrow 0} \frac{\log(1+5x)}{x}$
 (a) e (b) 5 (c) ∞ (d) 2

7. $\lim_{x \rightarrow 0} \frac{6^x - 3^x}{4^x - 1}$
 (a) 0 (b) 2 (c) 1 (d) $\frac{1}{2}$

8. If $y = x^x$, find $\frac{d^2 y}{dx^2} - \frac{1}{y} \left(\frac{dy}{dx}\right)^2 - \frac{y}{x}$
 (a) 1 (b) 2 (c) 0 (d) $\frac{1}{2}$

9. If X_1 and X_2 have independent Poisson distribution with parameters λ then X_1+X_2 is distributed as Poisson with parameters
 (a) λ (b) $\lambda/2$ (c) 2λ (d) λ^2

10. If X has exponential distribution with mean $\frac{1}{m}$ then the $\frac{P[X \geq x]}{P[X \geq 2x]}$ is equal to
 (a) $\exp(-mx)$ (b) $\exp(-x)$ (c) $\exp(-x/m)$ (d) $\exp(mx)$

11. Suppose X has binomial with mean 3 and variance 2, then
 (a) $P[X=0] < P[X=9]$ (b) $P[X=0] = P[X=9]$
 (c) $P[X=0] > P[X=9]$ (d) $P[X=0] = 9P[X=9]$

12. Match List I with List II and select the correct answer using the codes given below the lists

- List I
 A. Uniform distribution (0,1)
 B. Exponential distribution
 C. Binomial distribution
 D. Poisson distribution
 (a) (A,1), (B,4), (C,3), (D,2)
 (b) (A,4), (B,1), (C,3), (D,2)
 (c) (A,1), (B,4), (C,2), (D,3)
 (d) (A,4), (B,1), (C,2), (D,3)

- List II
 1. Mean = Standard deviation
 2. Mean = Variance
 3. (Variance/Mean) is less than 1'
 4. $6(\text{variance}/\text{mean}) = 1$

13. Let Z be a random variate having standard normal distribution and $P[Z > Z(\alpha)] = \alpha$, $0 < \alpha < 1$, then
 (a) $Z(1-\alpha) = -Z(\alpha)$ (b) $Z(1-\alpha) = Z(\alpha)$
 (c) $Z(1-\alpha) = 1 - Z(\alpha)$ (d) $Z(1-\alpha) = 2Z(\alpha)$

14. If X is distributed as Normal with mean μ and variance μ^2 then $E(X^2)$ is equal to
 (a) $\mu^2 + \mu$ (b) $2\mu^2$ (c) $\mu^2 - \mu$ (d) μ^2

15. Match list I with list II and select correct answer using the codes given below the list

- List I
 A. Geometric
 B. Poisson
 C. Binomial
 D. Uniform

- List II
 1. Tossing of coin
 2. Tossing a die
 3. Tossing of coin till head appears
 4. Telephone calls arriving at single booth

- a) (A,3), (B,4), (C,2), (D,1)
 b) (A,4), (B,3), (C,2), (D,1)
 c) (A,3), (B,4), (C,1), (D,2)
 d) (A,4), (B,3), (C,1), (D,2)

16. You are given $P(A \cup B) = 0.7$ and $P(A \cup \bar{B}) = 0.9$. Determine $P(A)$.

- (a) 0.2 (b) 0.3 (c) 0.4 (d) 0.6

17. $\int_{-\infty}^x \frac{1}{\pi(1+t^2)} dt$ is

- a) $\frac{1}{\pi} \tan^{-1} x$ b) $\frac{1}{2} + \frac{1}{\pi} \tan^{-1} x$
 c) $\frac{1}{2} - \frac{1}{\pi} \tan^{-1} x$ d) $\frac{1}{\pi} \tan^{-1} x - \frac{1}{2}$

18. $\int_a^b \frac{e^{tx}}{b-a} dx$ is

- a) $t(e^{tb} - e^{ta}) / (b-a)$ b) $(e^{tb} - e^{ta}) / [t(b-a)]$
 c) $te^{t(b-a)}$ d) $e^{t(b-a)} / t$

19. Which of the following matrices has rank two?

- a) $\begin{pmatrix} 1 & 3 \\ 2 & 4 \end{pmatrix}$ b) $\begin{pmatrix} 1 & -1 \\ -1 & 1 \end{pmatrix}$ c) $\begin{pmatrix} 1 & -3 \\ -3 & 9 \end{pmatrix}$ d) $\begin{pmatrix} 1 & 2 \\ 2 & 4 \end{pmatrix}$

20. A random sample of four policyholders is taken from a group of eight, comprising three men and five women. If the random variable X denotes the number of male policyholders in the sample then X can take values.

- a) $\{1,2,3,4\}$ b) $\{0,1,2,3\}$ c) $\{0,1,2,3,4\}$ d) $\{1,2,3\}$

21. $\int_0^{\infty} e^{-x} x^4 dx$ is

- a) 24 b) $\frac{1}{6}$ c) 6 d) $\frac{1}{24}$

22. IF $A = \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix}$ then $r(A) =$

- a) three b) two c) one d) zero

23. In a statistical experiment of tossing four coins simultaneously, if a random variable X represents number of heads appeared, then X has following distribution

- a) Geometric b) Binomial $\left(16, \frac{1}{2}\right)$
 c) Binomial $\left(4, \frac{1}{2}\right)$ d) Hypergeometric

24. A box contains 100 items out of which 20 are defective. If 4 items are picked at random from that box and X denotes number of defective items out of four then X has following distribution

- a) Binomial b) poisson c) negative binomial d) hypergeometric

25. Let X_1 be $b(2, p)$ and X_2 be $b(4, p)$. If $\Pr[X_1 \geq 1] = \frac{5}{9}$, the $\Pr[X_2 \geq 1]$ is

- a) $1 - \left(\frac{3}{4}\right)^4$ b) $\left(\frac{3}{4}\right)^4$ c) $1 - \left(\frac{2}{3}\right)^4$ d) $\left(\frac{2}{3}\right)^4$

26. Random variable X follows binomial distribution with parameters n and p. If for the Binomial distribution $E(X) = 5$ and $\text{Var}(X) = 4$, then pair (n, p) is

- a) $\left(25, \frac{1}{5}\right)$ b) $\left(25, \frac{4}{5}\right)$ c) $\left(16, \frac{1}{5}\right)$ d) $\left(16, \frac{4}{5}\right)$

$$27. \int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi}} x^2 e^{-\frac{1}{2}x^2} dx$$

- a) -1 b) 1 c) $\frac{1}{2}$ d) $-\frac{1}{2}$

28. Summary of observed values of random variable X is as follows 3 times -g, 5 times g, 2 times 0

Average value of X is

- a) .3g b) .5g c) -.2g d) .2g

29. A and B alternately toss a fair coin. The first one to throw a head wins. If A starts, probability that A wins is

- a) $\frac{1}{2}$ b) $\frac{1}{3}$ c) $\frac{2}{3}$ d) $\frac{1}{6}$

30. The probabilities of solving a problem by three students A, B and C are respectively $\frac{3}{7}$, $\frac{3}{8}$ and $\frac{1}{3}$. If all of them try independently, probability that the problem will not be solved is

- a) $\frac{5}{21}$ b) $\frac{3}{7}$ c) $\frac{2}{3}$ d) $\frac{3}{8}$

31. A small company paid each of its five clerks Rs. 22,000, each two stenographers Rs. 50,000 each and the director Rs. 2,70,000 last year. The number of employees earning less than mean salary is

- a) 0 b) 4 c) 5 d) 7

32. If $P[X=2] = 1$, then $(E(X), V(X))$ is

- a) (2,0) b) (2,2) c) (0,2) d) (2,1)

33. The mean and variance of -2,0,2 are respectively

- a) (0,2) b) (2,8) c) $\left(0, \frac{8}{3}\right)$ d) (-2,2)

34. If Q_1 and Q_3 are first and third quartiles then

- a) $Q_1 > \text{median} > Q_3$ b) $Q_1 < \text{median} < Q_3$

c) $\text{median} < Q_1 < Q_3$

d) $\text{median} > Q_3 > Q_1$.

35. A student randomly guesses at the two questions on a true or false quiz. Let X = number of correct guesses. The mean of X is.

- a) 1 b) $\frac{1}{2}$ c) 2 d) 0

36. Mean and standard deviation of (5,5) is

- a) 5,5 b) 10,5 c) 5,0 d) 0,5

37. If A and B are two nxn square matrices then determinant of AxB is equal to

- a) Det A x det B b) det A + det B c) n. det A d) n.det B.

38. If X follows normal distribution with mean zero and variance 2. Then max f(x) is

- a) $\frac{1}{\sqrt{2\pi}}$ b) $\frac{1}{2\sqrt{\pi}}$ c) $\frac{1}{2\pi}$ d) 1

39. The distribution of marks of a large group of high school students is normally distributed with $\mu = 60$ and $\sigma = 4$. The probability that a randomly selected student has marks more than 60 is

- a) .25 b) .05 c) .5 d) .80

40. If X follows $N(5, \sigma)$ which of the following is false?

- a) Mean of X is five b) Median of X is five
c) Mode of X is five d) X is symmetric about zero
