



# YASHWANTRAO CHAVAN MAHARASHTRA OPEN UNIVERSITY, NASIK

## HOME ASSIGNMENT (2016-17)

### V45 - BSAS 2011 Pattern Semester 6

#### Instructions for the Students :

1. All Questions are compulsory.
2. Write every question's answer on separate page.
3. Use of Scientific Calculator is allowed.
4. Use of Actuarial Tables is permissible.

#### S04061 (Life Insurance Pricing)

- Q1 (i) Find EPV of Benefit of 1 million on death to a life aged 42.25 years, if  $\mu = 0.02$  and  $\delta = 0.05$ . (2)
- (ii) Calculate the mean of the present value of benefits under an annuity payable to a life aged 35 exact. The annuity has payments of 1 per annum payable continuously for life.
- Basis: Mortality  $\mu = 0.02$  throughout  
Interest  $\delta = 0.05$  (3)
- Q2 At the age of 60 years exact, Rajesh purchases an annuity for a purchase price of Rs. 5,000,000.
- The annuity is payable monthly in advance and is certain to be paid for first 5 years and guaranteed for life thereafter. Calculate the monthly annuity amount using the following basis:
- |               |   |               |     |
|---------------|---|---------------|-----|
| Mortality     | : | AM92 Ultimate |     |
| Interest rate | : | 6% pa         |     |
| Expenses      | : | Nil           | [5] |
- Q3 On 1 January 1996 an office issued a number of annual premium policies to a group of lives, each of whom was then aged exactly 45. All policies were for a term of 20 years and were pure endowment policies under which the only benefit payable is the sum assured on survival to the end of the policy term.
- Assuming that there are no sources of decrement other than death, calculate the profit/loss from mortality for the calendar year 2005, in respect of the policies issued to this group of lives, given the following information:
- |   |                |
|---|----------------|
| Type of policy  | Pure Endowment |
| Sum Assured in force at 1 <sup>st</sup> January, 2005 | Rs. 50,000     |
| Sum assured discontinued                              | Rs. 1,000      |
- Provisioning basis: AM92 ultimate mortality and 4% p.a. interest. Ignore Expenses. [5]

Q4 A life insurance company issues a 35-year endowment assurance contract to a life aged 30 exact. The sum assured of £200,000 is payable at maturity or at the end of the year of death if earlier. Level premiums are payable annually in advance for the duration of the contract.

Show that the annual premium is approximately £2,007, using the following Basis

Interest	:	6% p.a.
Mortality	:	AM92 Ultimate
Expenses	:	Initial : £300 plus 50% of the annual premium
		Renewal : 2% of the second and subsequent annual premiums
		Claim : £600 on death; £200 on maturity

[5]

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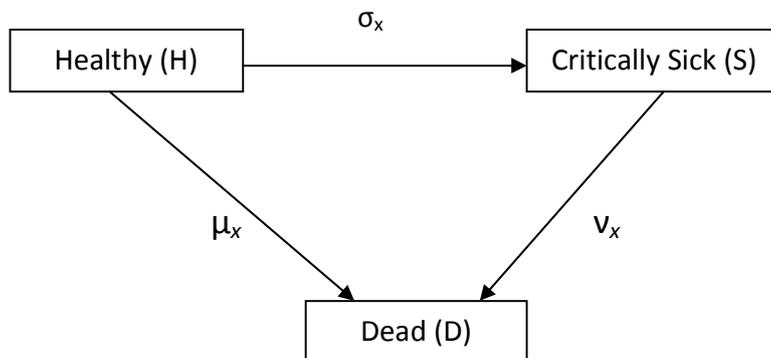
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S04062 (Reserving and Joint Life Distributions)

- Q1 Two lives aged  $x$  and  $y$  take out a policy that will pay out £15, 000 on the death of  $(x)$  provided that  $(y)$  has died at least 5 years earlier and no more than 15 years earlier.
- i) Express the present value of this benefit in terms of the random variables denoting the future lifetimes of  $(x)$  and  $(y)$ . (2)
  - ii) Give an integral expression (in terms of single integrals only) for the expected present value of the benefit. (3)
- Q2 Describe the main features of a unit-linked policy. [5]
- Q3 An insurance company is considering the sale of a "critical illness extra" term assurance policy. The critical illness benefit is £25,000, payable immediately on diagnosis of a critical illness within the 25-year term. The death benefit is £75,000, payable immediately on death.

Only one benefit is payable under any one policy and once the benefit has been paid, both the premiums and the cover cease. Annual premiums of £ $P$  pa are payable continuously.

The company assesses the profitability of the policy using the following multiple state model:



$p_{x,t}^{ab}$  is defined as the probability that a life who is in state a at age x (a = H, S, D) is in state b at age x + t (t ≥ 0 and b = H, S, D).

- i) Express in integral form, using the probabilities and the various forces of transition, the expected present value of one such policy with an annual premium of £1,200, that has just been sold to a life aged exactly 50. [2]

After careful consideration, the company modifies the policy by changing both the death benefit and the critical illness benefit to be £50,000.

- ii) You are given  $\mu_x = 0.0006$ ,  $\nu_x = 0.03x$ ,  $\sigma_x = 0.0014$  for all  $45 < x < 70$  and the force of interest is  $\delta = 4\%$ .

Calculate the expected present value of the benefits for the modified policy sold to a life aged exactly 45. [3]

- Q4 You are given the following statistics in relation to the mortality experience of Actuarial and its province Giro:

Age	Actuarial		Giro	
	Exposed to Risk	Number of deaths	Exposed to Risk	Number of deaths
0 - 19	300,000	25	12,000	2
20 - 39	275,000	35	10,000	3
40 - 59	200,000	100	9,000	6
60 - 79	175,000	500	8,000	50

- i) Explain, giving a formula, the term Standardised Mortality Ratio (SMR). Define all the symbols that you use. [2]
- ii) Comment on the relative mortality of the province, by calculating the SMR for Giro. [3]



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S04063 (Portfolio Theory Development)

- Q1 At the quarterly meeting of the Auger Close Investment Club, four members are making proposals for new equity investment for the club.

Albert wants to buy shares in Armadillo Adventures, claiming that they have performed poorly in recent weeks and are due an upturn.

Brian wants to invest in Biscuits-R-Us. They have recruited a new head of marketing, who has had success at other companies. Brian feels that this new appointment will have a positive effect on the firm.

Colin selects shares at random. This quarter he is recommending the club buy into Cash 4 Kidneys PLC.

Dennis wants the club to buy shares in Diamond Dentists ("DD"). His brother works for a major health insurer and has insider information that DD's shares will rise sharply in the near future, when it is announced that his company has appointed DD as its "dentist of choice".

For each club member, describe how their share selection strategy would work in strongly efficient, semi-strongly efficient, weakly efficient and inefficient markets. [5]

- Q2 Consider a multiple state, one-period pricing model in which there are two assets X and Y that provide payoffs in each of the next-period states as follows.

State	Probability of state occurrence	X	Y
Good	42%	1.65	2.20
Bad	58%	1.20	1.10
Market Price	----	1.36	1.50

[Hint: Good state price pays 1 in good state and 0 in bad state]

- i) Find the state prices for both the good and bad states. (3)
- ii) Find the expected return on each asset. (2)

Q3 In an investment market there are three risky assets available. The table below shows the returns each of the assets will earn in the three possible states of the world and the current market capitalisation of the assets. Assume a risk free rate of return of 4% is available.

States	Probability	Asset 1	Asset 2	Asset 3
1	0.4	5%	6%	7%
2	0.1	8%	2%	1%
3	0.5	3%	5%	4%
Market Capitalisation	----	30,000	50,000	30,000

Calculate the market price of risk under the CAPM. [5]

Q4 i) Define Martingale in continuous time. (1)

ii) Show that  $\exp[23B_t - (529/2)t]$  is a martingale. (4)

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S04064 (Derivative Pricing and Risk Management)

Q1 On May 1, 2008, Share price of Infosys is:

Bid Price	Offer Price
Rs. 1400.00	Rs. 1400.70

The Future contract price is:

Bid Price	Offer Price
Rs. 1410.60	Rs. 1411.00

The contract expires on May 31, 2008. At the expiry of the contract, both future price & share price are equal. The risk free rate is 6% pa continuously compounded.

Is there any arbitrage opportunity available?

We can assume that:

- No margin is paid while entering into a Future contract.
- No commission is paid while entering or exiting any contract. [5]

Q2 The price of a stock is currently Rs. 500. Over each of the next two 3-month periods the stock price is expected to go up by 6% or down by 5%. The risk free interest is 5% per annum with continuous compounding.

- i) What is the value of a six-month American put option with a strike price of Rs. 510? (3)
- ii) Suppose in the real world the expected return is 9%. What is the expected payoff of the European call option after 3 months? Explain with reasons whether you would be able to calculate the no-arbitrage value of such an option or not. (2)

Q3 A one-year European call option on a non-dividend paying stock in Company ABC has a strike of \$150.

The continuously compounded risk-free rate is 2% p.a. The current stock price is \$117.98. Assume that the market follows the assumptions of a Black-Scholes model.

An institutional investor holds a delta-hedged portfolio with 100,000 call options, no cash and short 18,673 shares of Company ABC.

The implied volatility is calculated as 22% p.a.

Calculate the price of a one-year put on the same stock with a strike of \$150. [5]

Q4 Companies A and B are joint investors in a high risk project to build a new space plane.

Each of the two companies' zero-coupon bonds are modeled according to a two-state model. Company A's bonds have a recovery rate of  $\delta_A = 60\%$ , while Company B's have a recovery rate of  $\delta_B = 50\%$ . All bonds mature in nine months.

Company A's bonds have a current price of \$82 per \$100 nominal, Company B's bonds have a current price of \$79 per \$100 nominal. The continuously compounded risk-free rate is 1.5% p.a.

Calculate the implied risk-neutral default intensities  $\lambda_A$  and  $\lambda_B$ , assuming that they are constant. [5]

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