YASHWANTRAO CHAVAN MAHARASHTRA OPEN UNIVERSITY, NASIK

HOME ASSINGMENT - (2016-17)

....

M.Sc. Actuarial Science (v46)

....

Instructions for the Students:

1) All Questions are compulsory.

2) Each Sub-question carries 5 marks.

3) Each Sub-question should be answered between 75 to 100 words. Write every question's answer on   separate page.

....

V46: S14011 : mathematics of finance -I

1   i)   A sum of `10,000 is borrowed, to be repaid in 3 years' time by a payment of `12,000. Calculate the corresponding effective rate of discount.   [1]

       ii)   Calculate the effective annual rate of interest for a transaction in which `20,000 is invested for 18 months to give `35,000.   [1]

       iii)   Calculate the accumulated value of an investment of `1000 for 6 months at a rate of interest of 5% *pa* convertible monthly.   [1]

       iv)   Calculate the discounted present value of `7800 due in six years if the force of interest per annum is 6%.   [1]

       v)   An investor must make a payment of `30,000 in 10 years' time. The investor wishes to make provision for this payment by investing a single sum now in a deposit account that pays nominal rate of discount of 9.68% *pa* convertible quarterly. How much should the initial investment be?   [1]

2   The force of interest, $\delta(t)$, is a function of time and at any time t (measured in years) is given by:

$\delta(t)$ = 0.03   for $0 \leq t \leq 10$
           = at for $10 < t \leq 20$
           = bt for $t > 20$ where a and b are constants.

The present value of 100 units due at time 20 is 50 units and present value of 100 units due at time 28 is 40 units. Calculate a and b.   [5]

3   Calculate the present value of an annuity payable annually in advance for a term of 20 years such that the payment is `5000 in year 1, `5500 in year 2, `6000 in year 3 *etc*. Assume a rate of interest of 5% *pa* for the first twelve years and 7% *pa* thereafter.   [5]

4   A loan of `100,000 is repaid over a five-year period by level monthly repayments in arrears of `2500. Calculate:

    i)   Flat rate of interest per annum   [2]

    ii)   APR on the transaction.   [3]

V46: S14012 : mathematics finance II

1   The fund value of an individual pension fund account was `95,000/- on 1st July 2006 and `1,65,065/- on 30th June 2012. During the period the investor made a payment of `9,000/- on 1st July 2009 and didn't withdraw any amount.

      The fund manager found that between 1st July 2006 and 1st July 2012, the Money-Weighted rate of return for the account was 1.25 times its Time-Weighted rate of return.

      Calculate the fund value as on 30th June 2009.   [5]

2   A loan of nominal amount `100,000 is to be issued bearing coupons payable quarterly in arrear at a rate of 7% per annum. Capital is to be redeemed at `108 per `100 nominal on a coupon date between 15 and 20 years inclusive after the date of issue. The date of redemption is at the option of the borrower.

      An investor who is liable to income tax at 25% and capital gains tax at 40% wishes to purchase the entire loan at the date of issue. Determine the price which the investor should pay to ensure a net effective yield of at least 5% per annum.   [5]

3   Three bonds, each paying annual coupons in arrear of 4% and redeemable at par, reach their redemption dates in exactly one, two and three years' time, respectively. The price of each bond is `96 per `100 nominal.

    i)   Calculate, showing all workings, the one-year and two-year spot rates of interest implied by the information given.   [3]

    ii)   Calculate the forward rate of interest applicable over the second year.   [2]

4   The Return on funds earned by a fund manager has a mean of 10% and a standard deviation 20%, and is independent of return earned in previous years. Each year the value of $(1 + i_t)$ is log-normally distributed, where i_t is the return earned in the tth year.

Determine the probability that the value of a single investment of `25,000 accumulates to more than `35,000 in 4 years' time.   [5]

V46: S14013 : statistics for actuaries I

The following amounts are the size of claims (in Rs.) on house insurance policies for a certain type of repair.

9900, 14000, 11500, 10900, 13000, 11000, 11800, 11500, 10300, 11000, 11800, 10100, 10600, 11600, 11200
   i) Two statisticians, A and B find the inter quartile range as 1075 and 1200 respectively. Comment on whether statistician A or B or both are correct.   (3)
   ii) Determine the sample mean and sample variance of the data.   (2)

2(a) A pair of events A and B cannot be simultaneously mutually exclusive and independent.
     Prove that if P(A) > 0 and P(B)> 0 , then

   i)   If A and B are mutually exclusive, they cannot be independent.
   ii)   If A and B are independent, they cannot be mutually exclusive.   (2)

2(b) Claim sizes in a certain insurance situation are modelled by a distribution with moment generating function M(t) given by
          $M(t) = (1 - 10t)^{-2}$.
Determine first three raw moments of X.   (3)

3 (a) A continuous random variable *X* has the following *pdf*

     $f(x) = k \, x \, \exp(-x^2/2)$; k is a constant. $x > 0$

   Find the value of *k* for *f(x)* to be a valid probability density function.   (2)

3(b) Joint probability distribution of random variables X and Y is as under:-

x\ y	0	1	4
-1	1/6	1/3	0

0	1/12	0	0
1	1/12	0	1/3

Calculate (i) E(X|Y=1), (ii) V(X|Y=1), (iii) E(XY).   (3)

4 There are two continuous probability distributions:
  Distribution A is an exponential distribution with mean = 75
  Distribution B is Uniform on the interval from 0 to 80, and thereafter proportional to A.

  Determine the probability of a random variable that follows distribution B has its value
  between 0 and 100.   (5)

V46: S14014: statistics for actuaries II

1 An insurer has collected data about the body mass index of 200 males between the age of 18
  and 40. The results are shown in the following table.

Body mass index	< 18.5	18.5 – 25	25 – 30	>30
Observed frequency	16	94	72	18

  A statistician suggests the following model for the distribution of the body mass index with an
  unknown parameter p.

Body mass index	< 18.5	18.5 – 25	25 – 30	>30
Relative frequency	p	$6p$	$1 – 8p$	p

  Estimate the parameter p using the method of maximum likelihood.   [5]

2 A survey, carried out at a major flower and gardening show, was concerned with
  the association between the intention to return to the show next year and the purchase of
  goods at this year s show. There were 220 people interviewed and of these 101 had made a
  purchase; 69 of these people said they intended to return next year. Of the 119 who had not
  made a purchase, 68 said they intended to return next year.

  By testing the difference between the proportions of purchasers and non-purchasers who
  intend to return next year, examine whether there is sufficient evidence to justify conclusion
  that the intention to return depends on whether or not a purchase was made.
                                                                                            [5]

3 Based on sample data: $n = 80$, $r = 0.56$ Test H_0: $\rho = 0.5$ against H_1: $\rho \neq 0.5$ at 5% level of significance. [5]

4 In order to compare the effectiveness of two new vaccines, A and B, for a childhood disease, 11 infants were immunised with vaccine A and 9 infants were immunised with vaccine B. One month after immunisation the concentration of the disease antibodies in the blood of each infant was recorded in appropriate units. The sample mean and variance for each group is given below.

Vaccine A: $n_A = 11, \bar{x}_A = 4.05, s_A^2 = 0.692$

Vaccine B: $n_B = 9, \bar{x}_B = 4.36, s_B^2 = 0.813$

It is assumed that the distributions of the antibody concentration levels after immunisation with vaccine A and vaccine B are N (μ_A, σ_A^2) and N (μ_B, σ_B^2) respectively. You may assume that the samples are independent.

(i)   State the distribution of the pivotal quantity $\dfrac{s_A^2 / \sigma_A^2}{s_B^2 / \sigma_B^2}$. [1]

(ii)   Calculate an equal-tailed 95% confidence interval for the ratio $\dfrac{\sigma_A^2}{\sigma_B^2}$ using the pivotal quantity in part (i).

(You are not required to show the derivation of the interval.) [4]

V46: S14015 :corporate finance and financial reporting I

1 A company s external auditor has warned that the next audit report might be qualified unless the financial statements are amended prior to publication. Explain the significance of a qualified audit report. [5]

2 The following balances have been extracted from the books of JK plc, as at 31 August 2005:-

	£000
Advertising	90
Cash at bank	8
Creditors	52
Debtors	134
Directors remuneration	85
Head office running costs	200
Interest on long term loans	9
Investment income	20
Investments (long term)	450

Long term loans	400
Materials and other manufacturing costs	800
Ordinary dividend paid	60
Ordinary share capital	900
Plant and machinery cost	250
Plant and machinery depreciation at 31 August 2004	100
Premises cost	1,200
Premises depreciation at 31 August 2004	15
Profit and loss at 31 August 2004	374
Sales	2,200
Stock at 31 August 2004	210
Wages and salaries administrative staff	110
Wages and salaries manufacturing staff	400
Wages and salaries sales staff	55

Additional information:
1. Premises are to be depreciated at the rate of 2% on cost and plant and machinery at 20% reducing balance.
2. Stock at 31 August 2005 was £180,000.

Calculate **Operating profit** of JK plc for the year ended 31sy August, 2005.   [5]

3 (i) List all circumstances under which companies may be considered to be group companies, and explain why shareholders will be interested in consolidated accounts.   [3]

 (ii) Explain the consolidation process of income statements and statements of financial   position of the individual group member.   [2]

4 Construct the balance sheet of SURPRISE Industries as on 31st March 2016 based on the information provided below –
          Asset Cover = 1.6
          Asset Gearing Ratio = 0.5
          Quick Ratio = 0.75
          Current Ratio = 2
Other information as on 31st March 2016 –
1. Current Liabilities is Rs. 60,000/-
2. 10% unsecured loan stock is Rs. 1,50,000/-
3. Intangible assets is Rs. 60,000/-
4. Current assets comprises of only cash and inventories
5. Loan capital and equity share capital constitutes equal proportion of balance sheet   [5]

V46: S14016 :corporate finance and financial reporting II

1(a) Explain agency cost and its components.   [3]

  (b) Distinguish between Partnership and Limited Liability Partnership.   [2]
                                                                                  [5]

2 (a) Explain the role of underwriting in an issue of shares.   [3]

  (b) Which of the following items would be subject to capital gains tax in UK? (Justify your answers.)
       1. The sale of Mr Ralph's main house.
       2. The sale of Mr Ralph's $10,000 purchased earlier for spending during his vacation to Alaska, making a gain of £240 due to currency fluctuation
       3. The sale of Mr Tim's collection of paintings (valued at £5,999).
       4. The transfer of Mr Tim's holiday cottage to his unmarried sister.   [2]
                                                                                   [5]

3 A quoted company has a policy of making relatively small dividend payments, with profits being reinvested in the business. A period of slow growth in the industry has left the company with a substantial cash surplus as a result of this policy.

Discuss the advantages to the company and shareholders of reducing this surplus by means of a share buyback rather than a dividend payment.   [5]

4 Consider a capital project involving the construction of factory building The company has already entered into agreements to supply products to some bulk users starting in a year's time. Give examples of how the risks associated with this project might be mitigated.   [5]

V46: S14031 :life contingencies I

1 A term assurance contract for a life aged 50 exact for a term of 10 years provides a benefit of 1,000,000 payable at the end of the year of death. Calculate the expected present value and variance of benefits payable under this contract.
  Basis: Mortality: AM92 Select
          Interest: 4% per annum   [5]

2(a) Explain what is select mortality. [2]

(b) A population is subject to the force of mortality $\mu_x = e^{0.0002x} - 1$.

Calculate the probability that a life now aged 20 exact dies between ages 60 exact and 70 exact.
[3]

3 A Special Endowment Assurance contract is issued to a life aged 40 for a term of 25 years.
The Death Benefit = Sum Assured of 100,000 is payable immediately on death.
Survival Benefit = 200,000 is payable at the end of the term on survival.
Calculate the Net Premium p.a.
Basis: AM92 Mortality with 4% interest rate. [5]

4 Describe and compare three types of reversionary bonus that may be given to a with-profits contract. [5]

V46: S14032 : life contingencies II

1 Two lives are both aged 45 exact.
Calculate:
(i) The probability of both lives surviving to age 65 exact. (1)
(ii) The present value of an annuity of £1,000 per annum increasing by 3% each year payable annually in advance so long as both lives survive. (4)
Basis:
Mortality $\mu_x = 0.05$ for all x for both lives
Interest 4% per annum [5]

2 A special 3-year level term assurance policy pays the sum assured at the end of the year of death. Level annual premiums are required to be paid at the start of each year. Policies may lapse at the end of each policy year without any benefits payable.

The premium basis is as follows:

Interest:	8% per annum	
Mortality:	AM92 Select	
Lapse rates:	10% of all policies in force at the end of year 1	
	5% of all policies in force at the end of year 2	

Expenses:	Initial Fixed	Rs. 2,000
	Initial Variable	75% of annual premium
	Renewal Fixed	Rs. 100 at start of year 2
		Rs. 105 at start of year 3
	Renewal Variable	5% of annual premium at start of years 2 and 3

| | Termination | Rs. 500 per death |
| Reserves: | 50% of the total premiums paid till date. |

The policy and life assured details of a particular contract are as follows:

Sum Assured:	Rs 10,000,000
Annual Premium:	Rs 50,000
Age at entry:	50 years (exact)

Calculate Profit Margin if the Profit Vector is (-30826.64, 3500.40, 73665.02)   [5]

3 The staff of a company is subject to two modes of decrement, death and withdrawal from employment. Decrements due to death take place uniformly over the year of age in the associated single-decrement table. 40% of the decrements due to withdrawal occur uniformly over the year of age and the balance occurs at the end of the year of age, in the associated single decrement table. You are given that the independent rate of mortality is 0.002 per year of age and the independent rate of withdrawal is 0.2 per year of age.

Calculate the probability that a new employee aged exactly 40 will die as an employee at age 41 last birthday.   [5]

4 An employer wishes to introduce a lump-sum retirement benefit payable immediately on retirement at 65 or earlier other than on the grounds of ill-health. The amount of the benefit is £1,000 for each year of an employee s service, with proportionate parts of a year counting.

Give a formula to value this benefit for an employee currently aged x with n years of past service, defining all terms used.   [5]

V46: S14033 financial economics I

1(a) XYZ has just announced that its profits are up by 52% on last year. On the announcement XYZ shares fell in price by 20%. Analysts had been predicting a rise in profits of 65%. A friend says that this shows that the efficient markets hypothesis is false.
Comment on this statement.   [2]

1(b) A quadratic utility function is given by the equation $U(w) = w + bw^2$. The value of absolute risk aversion at a value of wealth of one unit is 0.25
Calculate the value of b and the range over which $U(.)$ satisfies the condition of non-satiation.
     [3]

2(a) The return generated by an investment portfolio: R (in %) is modeled as follows:

$R = X - 0.5(12 - X), \quad where X \sim Binomial(12, 0.5)$

The benchmark level is set at 0%.

Calculate the shortfall probability. [2]

2(b) A market consists of two assets A and B. Annual returns on the two assets (R_A and R_B) have the following characteristics:

Asset	Expected return %	Standard deviation %
A	6	20
B	10	20

The correlation between the returns on the two assets is 0.25.

Calculate the proportion that would be invested in each of the two assets in a minimum variance portfolio. [3]

3 (a) Describe the properties of multifactor model of asset returns. You should define all the notations that you use. [2]

(b) Suppose that two factors have been identified for the Indian economy: the growth rate in industrial production (IP) and the inflation rate (IR). Suppose also that there are three portfolios X, Y, and Z, characterized by the following data:

Portfolio	Expected Return	Beta on IP	Beta on IR
X	15	1	0.6
Y	14	0.5	1
Z	10	0.3	0.2

What is the equilibrium expected-return beta relationship in the Indian economy? [3]

4 A(t) follows the stochastic equation

$A(t) = S(t).\exp[(R-r)(T-t)]$

and you are also given that

$dS(t) = S(t)[a dt + b dZ(t)]$

where Z(t) is the Standard Brownian Motion under the real world measure P.

Apply Ito's formula to derive an SDE satisfied by A(t). [5]

V46: S14034 :financial economics II

1 An European call and put option on a dividend paying stock both have a strike price of Rs. 50 and expire in 3 months. Both of them are available for Rs 10 each. The stock is currently trading at Rs 50 and is expected to pay a dividend of Rs 5 in three month's time just before the expiration of the options. Is there an arbitrage opportunity available? If yes, what trades should the trader execute to benefit from the opportunity?   [5]

2 A stock price is currently Rs.120. Over the next two three-month periods it is expected to go up by 4% or down by 3%. The risk free rate of interest is 6% per annum with continuous compounding.

 (i) What is the value of a six-month European call option with a strike price of Rs.123? (3)
 (ii)What is the value of a six-month European put option with a strike price of Rs.123? (2)
                                                                                          [5]

3 A stock is currently priced at 82. A writer of 100,000 units of a one year European call option on this stock with an exercise price of 80 has hedged the option with a portfolio of 75,000 shares and a loan. The annual risk-free interest rate (continuously compounded) is 7% and no dividends are payable during the life of the option.

 Assume the Black-Scholes pricing formula applies.
 (i) Derive an expression for the Delta of the option.
 (ii) State the value of the Delta in this case.   [5]

4 A company has the following three sources of capital on its balance sheet at time 0.

Source	Face Value	Maturity	Interest/dividend
Equity	20 million	Undated	None
Subordinated debt	8 million	5 years	None
Senior debt	5 million	5 years	None

 In case of liquidation, Senior debt takes priority over Subordinated debt and the Subordinated debt takes priority over Equity.
 Express the value of Subordinated Debt in terms of European put options.   [5]

V45: S14035 :communication and research methodology

1 A researcher wants to develop a dengue drug.

  Give steps in his research project.   [5]

2 Your friend has written to you saying that Five years ago he took a housing loan of Rs. 10,00,000 with a term of ten years. The loan was to be repaid by monthly EMIs starting immediately. He further mentioned that he paid his EMIs regularly for 5 years and then he thought off repaying the balance loan in one go as he suddenly got a share from sale of his family property. Your friend was shocked to find that the Bank that had granted him a loan demanded Rs. 6,16,933 against his expectation of Rs. 5,00,000. The Bank also said that they have not charged him any penalty for earlier repayment.

Write a letter to your friend explaining him why the Bank could be demanding much larger amount than 50% of the loan amount.   [5]

3 You stood FIRST in the last examination of CT1 held by Institutes of Actuaries of India. You are invited to give an inspirational speech to the students of XII standard in your school. Prepare a Power Point Presentation that will support your speech.   [5]

4 Your friend appeared for an interview today with a company, where you are scheduled for tomorrow. Your friend was asked:" If you were a type of food, what type of food would you be?"

If you were there in your friend's place, how would you have responded to this and why? [5]

V46: S14036 :business environment

1 What are differentiation strategies?   [5]

2 When non-provision of some uncertain liabilities will lead to widespread fallouts of organizations, actuarial work will increase. Explain how.   [6]

3 Explain Securitization. How was it responsible for Global recession of 2008?   [5]

4 Strategic risks do not include risk from certain factors. List them.   [5]