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**University Examinations 2015/2016**

SECOND YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN ACTUARIAL SCIENCE

**SMS 3263: FINANCIAL MATHEMATICS II**

 **DATE: NOVEMBER 2015 TIME: 2HOURS**

**INSTRUCTIONS:** *Answer question* ***one*** *and any other* ***two*** *questions*

**QUESTION ONE (30 MARKS)**

1. (i) What do you understand by an option premium (1 Mark)

(ii) Derivatives are mainly used to control risk. Explain two ways in which they achieve this. (2 Marks)

1. A 182-day government bill, redeemable at £100 was purchased for $£$96 at the time of issue and was sold later to another investor for £97.89. The rate of return received by the initial purchase was 5% per annum effective.
2. Calculate the length of time in days for which the initial purchaser held the bill. (2 Marks)
3. Calculate the annual simple rate of return achieved by the second investor. (2 Marks)
4. State the features of a Eurobond. (3 Marks)
5. A loan is issued bearing interest rate is 9% per annum and payable half-yearly in arrear. The loan is to be redeemed at £110 per £100 nominal in 13 years time. The loan is issued at a price such that an investor, subject to income tax at 25%, and capital gains tax at 30%, would obtain a net redemption yield of 6% per annum effective. Calculate the issue price per £100 nominal of the stock. (5 Marks)
6. (i) What is arbitrage? (1 Mark)

(ii) An investor purchases a 5-month forward contract on 1 January 2004 to buy 1000 shares at the end of the contract. The price of a share on 1 January 2004 is shs.50. Dividends are received continuously and the dividend yield is 6% pa. The risk free rate of interest is 4% pa effective and no arbitrage. Calculate the forward price. (4 Marks)

1. The 3,5 and 7-year spot rates are 6%, 5.7% and 5% pa respectively. The 3-year forward rate from time 4 is 5.2% pa. Calculate;
2. f3 (3 Marks)
3. f5,2 (3 Marks)
4. y4 (3 Marks)

**QUESTION TWO (20 MARKS)**

1. A bond paying annual coupons in arrears of 6% is redeemable at £105 per £100 nominal in three years time. The price of the bond is £103 per £100 nominal. Calculate the gross redemption yield of the bond. (5 Marks)
2. An investor purchases a bond 3 months after issue. The bond will be redeemed at par ten years after issue and pays coupons of 6% per annum annually in arrears. The investor pays tax of 25% on both income and capital gains. Calculate the purchase price of the bond per £100 nominal to provide the investor with a rate of return of 8% per annum effective. (8 Marks)
3. An investor who is liable to income tax at 20% but is not liable to capital gains tax wishes to earn net effective rate of return of 5% per annum. A bond bearing coupons payable half-yearly in arrear at a rate of 6.25% per annum is available. The bond will be redeemed at par on a coupon date between 10 and 15 years after date of issue, inclusive. The date of redemption is at the option of the borrower. Calculate the maximum price that the investor is willing to pay for the bond. (5 Marks)
4. State two main differences between government bonds and treasury bills. (2 Marks)

**QUESTION THREE (20 MARKS)**

An insurance company has liabilities consisting of eleven annual payments of £1 million with the first payment due to be made in 10 years’ time and the last payment due to be made in 20 years’ time. The rate of interest is 6% per annum effective.

1. Show that the discounted mean term of these liabilities to four significant figures is 14.42 years. (5 Marks)

The insurance company holds two zero-coupon bonds, one paying £x in 10 years’ time and the other paying £y in 20 years’ time.

1. Find the values of x and y such that Radington’s first two conditions of immunization from small changes in rate of interest are satisfied. (9 Marks)
2. A pension firm has liabilities of 87,500 due in 8 years’ time and £157,500 due in 19 years’ time. The current interest rate is 7% per annum effective. Calculate the discounted mean term and convexity of the liabilities. (6 Marks)

**QUESTION FOUR (20 MARKS)**

1. An eleven month forward contract is issued on 1 March, 2008 on a stock with a price of £10 per share at that date. Dividends of 50 pence per share are expected to be paid on 1 April and 1October 2008. Calculate the forward price at issue, assuming a risk-free rate of interest of 5% per annum effective and no arbitrage. (5 Marks)
2. State the characteristics of an equity investment. (5 Marks)
3. Explain five reasons as to why interest rate vary over the term of an investment. (10 Marks)

**QUESTION FIVE (20 MARKS)**

A pension fund holds an asset with current value of £1 million. The investment return on the asset in a given year is independent of returns in all other years. The annual investment return in the next year will be 7% with probability 0.5 and 3% with probability 0.5. In the second and subsequent years, annual investment returns will be 2%, 4% or 6% with probability 0.3, 0.4 and 0.3 respectively.

1. Calculate the expected accumulated value of the asset after 10 years, showing all steps in your calculations. (8 Marks)
2. Calculate the standard deviation of the accumulated the standard deviation of the asset after 10 years showing all steps in your calculations. (12 Marks)