



King Fahd University of Petroleum & Minerals

**First Major Examination**

<b>Faculty: Science</b>	<b>Department: Mathematics</b>
<b>Semester: 182</b>	<b>Course Name: Actuarial Science Problem Lab 1</b>
<b>Instructor: Abedalhay Elmughrabi</b>	<b>Course No: AS 288</b>
<b>Exam Date: February 20<sup>th</sup>, 2019</b>	<b>Exam Time: 120 minuets</b>

<b>Student Name:</b>	<b>ID No.:</b>
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<b>Question No.</b>	<b>Question Full Marks</b>	<b>Question Obtained Marks</b>	<b>Question No.</b>	<b>Question Full Marks</b>	<b>Question Obtained Marks</b>
1	5 points		11	5 points	
2	5 points		12	5 points	
3	5 points		13	5 points	
4	5 points		14	5 points	
5	5 points		15	5 points	
6	5 points		16	5 points	
7	5 points		17	5 points	
8	5 points		18	5 points	
9	5 points		19	5 points	
10	5 points		20	5 points	

**Obtained Total:**

**/ 100**



### **Exam Instructions**

1. Fill in all information required.
  2. The exam is composed of **20** questions.
  3. Only the following is allowed to be on your desk: SOA approved calculator, pen/pencil, eraser, and sharpener.
  4. Calculators cannot be exchanged during the examination.
  5. No use of smart devices with communications capabilities (mini laptops, pens, watches, phones, etc.)
  6. Cell phones must be turned off and placed under your bench facedown.
  7. No questions are allowed during the exam.
  8. All material related to the course should be put away
  9. Final correct answers have significant weights
  10. Answers without calculations/steps will receive zero marks.
  11. Be clean, neat and tidy, else your work may not be marked
  12. Students must not communicate with one another in any manner whatsoever during the examination.
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**GOOD LUCK**



**Questions 1:**

You purchase an  $n$ -year 2,000 par value bond with 7.5 percent annual coupons to yield an annual effective yield  $j$ . The book value of the bond at the end of year 13 is 2,236.61 and the book value of the bond at the end of year 14 is 2,220.80. What is the book value at the end of year 16.

- a. 2,166.62
- b. 2,176.57
- c. 2,186.29
- d. 2,194.83
- e. 2,195.56



**Questions 2:**

Determine the Macaulay duration of a share of common stock. Dividends are paid annually starting a year from now.

The first dividend  $X$ , and dividends will be paid annually after that; the annual growth rate of the dividends is 5%; and the interest rate 8%.

- a. 23.00
- b. 24.00
- c. 26.00
- d. 36.00**
- e. 51.00



**Questions 3:**

Determine which of the following statements is false with respect to Redington immunization.

- (A) Modified duration may change at different rates for each of the assets and liabilities as time goes by.
- (B)** Redington immunization requires infrequent rebalancing to keep modified duration of assets equal to modified duration of liabilities.
- (C) This technique is designed to work only for small changes in the interest rate.
- (D) The yield curve is assumed to be flat.
- (E) The yield curve shifts in parallel when the interest rate changes.



**Questions 4:**

A loan is amortized over 7 years with monthly payments at a nominal interest rate of 9% compounded monthly. The first payment is 2000 and is to be paid one month from the date of the loan. Each succeeding monthly payment will be 1% lower than the prior payment. Calculate the outstanding loan balance immediately after the 64th payment is made.

- a. 17,404
- b. 18,162
- c. 17,894
- d. 17,770**
- e. 17,498



**Questions 5:**

You are given the following information about an insurance company account

Assets beginning of the year	27,000,000
Sales Revenue	2,619,000
Investment income at the end of the year	1,890,000
Salaries paid	2,079,000
Other Expenses	540,000

All cash flow occurs except the net investment income at the middle of the year  
Calculate the annual effective yield rate.

- a. 7 %
- b. 11 %
- c. 4 %
- d. 2 %
- e. 8 %



**Questions 6:**

The table below shows the spot rates for the given lengths of time.

Number of years	1	2	3	4	5	6
Effective Annual Spot Rate	2.5 %	3.1%	3.4%	3.6%	4.0%	4.2%

Calculate the swap rate for a two-year deferred, three-year interest rate swap with settlement at the end of the year.

- (A) 3.4%
- (B) 3.7%
- (C) 4.1%
- (D) 4.6%**
- (E) 5.0%





**Questions 7:**

Aakash has a liability of 6000 due in four years. This liability will be met with payments of A in two years and B in six years. Aakash is employing a full immunization strategy using an annual effective interest rate of 5%.

Calculate  $|A - B|$ .

- (A) 0
- (B) 146
- (C) 293
- (D) 586**
- (E) 881



**Questions 8:**

You are given the following information about a 20-year bond with face amount 7500:

- i) The bond has an annual coupon rate of 7.4% paid semiannually.
  - ii) The purchase price results in an annual nominal yield rate to the investor of 5.3% convertible semiannually.
  - iii) The amount for amortization of premium in the fourth coupon payment is 28.31.
- Calculate the redemption value of the bond.

(A) 7660

(B) 7733

(C) 7795

(D) 7879

(E) 7953



**Questions 9:**

On January 1, a fund is worth 100,000. On June 1, the value has increased to 120,000 and then 30,000 of new principal is deposited. On October 1, the value has declined to 130,000 and then 50,000 is withdrawn. On January 1 of the following year, the fund is again worth 100,000.

Calculate the dollar-weighted rate of return using the simple interest approximation.

- (A) 0.00%
- (B) 19.05%**
- (C) 25.00%
- (D) 26.67%
- (E) 30.00%



**Questions 10:**

Jia Wen has a liability of 12,000 due in eight years. This liability will be met with payments of 5000 in five years and B in  $8+b$  years. Jia Wen is employing a full immunization strategy using an annual effective interest rate of 3%.

Calculate  $B/b$ .

(A) 2807

(B) 2873

(C) 2902

(D) 2976

(E) 3019



**Questions 11:**

Trevor has assets at time 2 of A and at time 9 of B. He has a liability of 95,000 at time 5. Trevor has achieved Redington immunization in his portfolio using an annual effective interest rate of 4%.

Calculate  $A \setminus B$ .

(A) 0.7307

(B) 0.9670

(C) 1.0000

**(D) 1.0132**

(E) 1.3686



**Questions 12:**

An investment of 1 will accumulate to 1.171963 in 4 years at a force of interest  $\delta$ . An investment of 1 will accumulate to 2.912164 in  $n$  years at a nominal rate equal to  $\delta$  and convertible every 2 years.

Find  $n$

- a. 34
- b. 40
- c. 25
- d. 28**
- e. 31



**Questions 13:**

You have a three-year, 200 face value, 9% annual coupon bond.  
The one-year spot rate of interest is 6%;  
The two-year spot rate of interest is 7.5%;  
The three-year spot rate of interest is 8%;  
Find the bond's price.

- a. 205.61
- b. 214.01
- c. 199.31
- d. 211.81
- e. 213.01



**Questions 14:**

Suppose that a fund initially containing 6000 accumulates with a force of interest

$$\delta(t) = \frac{1}{1+t}, \text{ for } t > 0$$

What is the value of the fund after 9 years?

- a. 62,000
- b. 48,000
- c. 42,000
- d. 72,000
- e. 60,000





**Questions 15:**

A loan of 40,000 is to be repaid during 4 years with equal monthly payments of  $p$ . The nominal interest rate convertible monthly for the first year is 4%, while the nominal interest rate convertible monthly for the remaining 3 years is 8%. What is principal component of the 6th payment?

- a. 1098.01
- b. 549.01
- c. 1235.27
- d. 823.51
- e. 411.76



**Questions 16:**

A company must pay liabilities of 4000 and 6000 at the end of years one and two, respectively. The only investments available to the company are one-year zero-coupon bonds with an annual effective yield of 8% and two-year zero-coupon bonds with an annual effective yield of 11%.

Determine how much the company must invest today to exactly match its liabilities.

- (A) 8,473
- (B) 8,573**
- (C) 8,848
- (D) 9,109
- (E) 10,000



**Questions 17:**

A 30-year annuity starts on January 1, 1992, and pays 500 at the beginning of each quarter. The interest rate is 8% convertible monthly. Find the accumulated value of this annuity on July 1, 2025.

- a. 332,739
- b. 334,427
- c. 334,491
- d. 334,253
- e. 330,587



**Questions 18:**

A 32-year loan is to be repaid in equal annual payments. The amount of interest paid in the 1th payment is 1803. The amount of interest paid in the 17th payment is 1237. Compute the annual payment.

- a. 2,229
- b. 2,280
- c. 2,333
- d. 2,233
- e. 2,326



**Questions 19:**

You deposit in a bank account 800 at the end of each year for 9 years and for the following 9 years, you deposit  $800+U$  at the end of each year. At the end of 18 years, your balance is 27,660. Find  $U$  if the account earns 4% effective interest rate.

- a. 1013
- b. 450
- c. 675
- d. 338
- e. 900



**Questions 20:**

A 11,000 par value 11-year bond with 9% annual coupons is bought at premium to yield an effective annual rate of 7%. Calculate the principal portion of the 6th coupon. This is also called the write down in the 6th coupon. The bond was bought at premium since  $9 > 7$ .

- a. 146.60
- b. 241.86
- c. 190.11
- d. 198.09
- e. 97.07