Department of Statistics
Jahangirnagar University
Part III B. Sc (Hons.) Examination-2021
Course Code: Stat-308
Course Title: Actuarial Statistics

Time: 2.5 Hours   Full Marks: 35

Answer Any Three of the Following Questions. All Questions Carry Equal Marks.

1. a) Explain with suitable examples principal, amount function and accumulated value.

b) Define simple and compound interest with suitable examples. Which one do you think better for developing countries like Bangladesh?

c) The Albert family buys a new apartment for 89500 on June 1, 1987. How much was this house worth on June 1, 1981 if real estate prices have risen at a compound interest rate of 7% per year during that period?

2. a) Explain the following terms with suitable examples:

i) Nominal and effective rate of interest
ii) Force of interest

b) What is the present value and discount? 1500 is to be accumulated by November 1, 1988, at a compound rate of discount of 8% per year.

i) Find the present value on November 1, 1982.
ii) Find the value of i corresponding to d, where i is the rate of interest and d is the rate of discount.

c) Consider the function $b(p)=\sqrt{1+(i^2+2i)p^2}$, $i>0, p>0$. Show that $b(p)<1+ip$ for $0<p<1$, but $b(p)>1+ip$ for $p>1$.

3. a) What is a loan amortization schedule?

b) Consider a loan which is being repaid by equal annual payments of 1 for n years. Construct an amortization schedule.

c) What is sinking fund schedule? A loan of L is to be repaid by sinking fund method over n years. Construct the sinking fund schedule for repaying of loan.

d) What is yield rate or internal rate of return for an investment? Explain.

4. a) Explain mathematically, why each of the following is true?

i) $_{n|m}q_x = {}_np_x - {}_{n+m}p_x$

ii) $_{n+m}p_x = {}_mp_x \cdot {}_np_{x+m}$

b) An annuity on (x) provides k annually beginning at age $(x+n)$. Nothing is paid before n years. Annual premiums are payable for n years beginning at x. Draw a cash flow diagram and obtain an expression for annual premium, assuming limiting age ω.

c) For a special 3-year temporary annuity-due on (55), you are given the following table

t	Annual payment	p_{55+t}
0	150	0.90
1	200	0.92
2	250	0.88

and $i=0.03$. Find net single premium for this contract.

5. a) Give some examples of gross premiums.

b) Draw a cash flow diagram of an n-year endowment insurance of face value 1 on (x). Derive an expression to find net single premium.

c) You are given

Mortality: Illustrative life table

x	l_x	d_x
25	8,640,861	77,426
26	8,563,435	83,527
27	8,479,908	90,082
28	8,389,826	

and $i = 0.05$. Calculate the net single premium of 3-year endowment insurance on (25) of 10,000.

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Course No. Stat 308

Time: 2.5 Hours

Full Marks: 35

[Answer any THREE questions. All questions carry equal marks.]

1. a) Explain actuarial science and write down the important uses of actuarial statistics especially in the context of Bangladesh.

b) Define insurance and explain in brief the life, health and group insurances.

c) Define accumulation and amount function. Briefly discuss simple and compound interest. Which one do you think better for developing countries like Bangladesh?

2. a) Exlain the following terms with suitable example:

i) Present value and discount

ii) Nominal rate of interest and force of interest

b) Robert borrows 1000 at 15% compound interest.

i) How much does he owe after 2 years?

ii) How much does he owe after 57 days, assuming compound interest between integral durations?

iii) (iii) How much does he owe after 1 year and 57 days, assuming compound interest between integral durations?

iv) How much does he owe after 1 year and 57 days, assuming linear interpolation between integral durations?

v) In how many years will his principle have accumulated to 2000?

c) A loan of 3000 is taken out on June 23, 1987. If the force of interest is 14%, find each of the following:

i) The value of the loan on June 23, 1992.

ii) The value of i.

iii) The value of $i^{(12)}$.

3. a) Define annuities with suitable example. Discuss its usefulness in actuarial science. Also discuss in brief, the perpetuities, varying annuities, and continuous annuities.

b) Prove each of the following identities along with a verbal interpretation.

i) $\ddot{a}_{\overline{n|}} = 1 + a_{\overline{n-1|}}$

ii) $\ddot{S}_{\overline{n|}} = S_{\overline{n-1|}} - 1$

c) John borrows 1500 from a finance company and wishes to pay it back with equal annual payments at the end of each of the next ten years. If $i = 0.17$, what should his annual payment be?

4. a) What do you mean by amortization and sinking fund? Write down the differences between amortization and sinking fund.

b) Formulate the general equation for bond and book value and find out the relationship between two.

c) Find the book value immediately after the payment of the 14th coupon of a 10-year 1,000 par-value bond with semiannual coupon, if $r = 0.05$ and the yield rate is 12% convertible semiannually.

d) Let B_t and B_{t+1} be the book values just after the t^{th} and $(t+1)^{st}$ coupons are paid. Show that $B_{t+1} = B_t(1+i) - Fr$, where the notations are as usual.

5. a) Explain the life table with its different components.

b) Given $l_x = 1000(1 - x/105)$, determine each of the following:

i) l_0

ii) l_{35}

iii) q_{20}

iv) ${}_{15}p_{35}$

v) ${}_{15}q_{25}$

vi) The probability that a 30-year-old dies between ages 55 and 60.

vii) The probability that a 30-year-old dies after age 70.

viii) The probability that, given a 20-year-old and a 30-year-old, one but not both of these individuals' reaches age 70.

c) A scientist studies the mortality patterns of Golden-Winged Warblers. She establishes the following probabilities of deaths: $q_{35} = 0.00037$, $q_{36} = 0.00040$, $q_{37} = 0.00047$, $q_{38} = 0.00061$, $q_{39} = 0.00081$. Starting with $l_{35} = 10000$, construct a mortality table.

d) Explain, both mathematically and verbally, why the following are true.

i) $l_x = d_x + d_{x+1} + d_{x+2} + \dots$

ii) $l_{x+n} = (l_x)(p_x)(p_{x+1})\dots(p_{x+n-1})$

iii) $q_x + (p_x)(q_{x+1}) + ({}_2p_x)(q_{x+2}) + \dots = 1$

Best of Luck