SIMON FRASER UNIVERSITY
Faculty of Business Administration

FINAL EXAM

BUS 411 Fixed Income Security Analysis 25-3
Prof. Geoffrey Poitras

Academic Honesty: This assignment is individual work. Students are required to follow requirements of S10.01, especially Appendix A (see class web page for link). For purposes of this course, the use of AI code generators is considered as borrowing from another individual, such usage is explicitly prohibited.

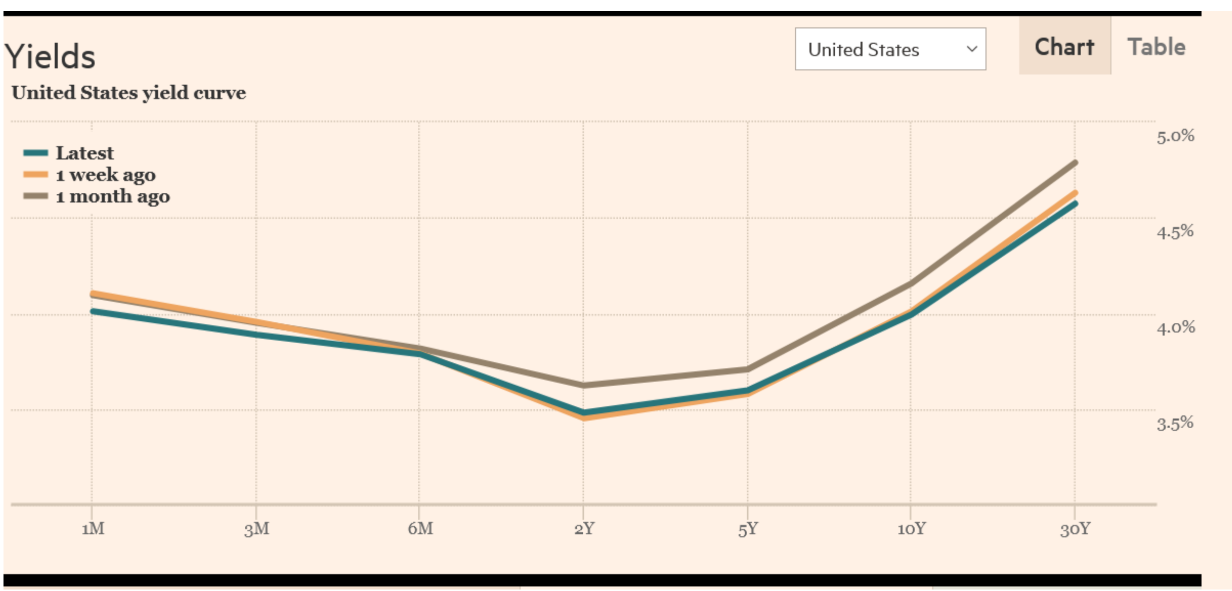
Rules for Submitting Final Exam: Exam is due in my email (poitras9@sfu.ca) no later than 3:30PM on Fri., Dec. 5, 2025. Late assignments will be assessed a 2% reduction per hour or part thereof, e.g., 11.5 hours late will have a 24% reduction.

DO ALL PARTS OF ALL QUESTIONS: Each question is worth 25 total points – for questions with two parts 10 points for part a) and 15 points for part b). Where applicable, provide calculations or code used to determine answers.

1. Explaining the Yield Curve

For the "Latest" Yield curve in the Chart below:

a) Calculate all annual implied zero coupon interest rates (z_t yearly) for the "latest" 1 to 10 year yield curve. With these z_t calculate a set of one year ahead implied forward rates (${}_t f_{t+1}$)



(Hint: Assume that the chart is for annual coupon par bond yields and that the 1-year yield is for a zero coupon.)

b) i) Assuming the unbiased expectations hypothesis is correct, solve for the market expectation of the 1-to-10 year term structure of interest rates in 1 year, 2 years and 3 years from the date of the yield curve given above. (Hint: This may involve solving more z_t than in part a)).
ii) Assuming that the yield curve in a) is expected to be unchanged over the next three years, calculate the liquidity premia associated with the implied forward rates from i). What do the calculated liquidity premia indicate about the validity of the liquidity premia hypothesis?

2. Fixed Income Portfolio Management

a) Using the par bond yield curve from Question #1, construct a portfolio of 2 year + 30 year bonds that has the same modified duration as the seven year bond. What are the convexities and 'time value' for the 2 + 30 year portfolio and the 7 year bond? Calculate and explain the 'time value-convexity' trade-off for this yield curve. What does this imply about the volatility estimate for a one-factor model of interest rates?

b) i) On Oct. 27, 2025 the Chemtrade Logistics 7% debenture maturing June 30, 2028 was selling for $121.15 (flat), what is the promised yield to maturity for this bond if the accrued interest is included in determining the yield to maturity and conversion features are ignored? On the same day, the Rogers Sugar 6% debenture maturing June 30, 2030 was selling for $105.00 (flat), what is the yield to maturity for this bond if accrued interest is included and conversion feature is ignored? How would the answers for the debenture yields change if the bond indenture for Rogers Sugar provides for conversion of par value into units at $7.10 and the stock is trading at $6.45 and the Chemtrade Logistics provide for conversion of par value into units at $12.85 and the units are trading at $13.45? Assuming straight bonds with a similar coupon, credit rating and term to maturity as the Chemtrade debentures are trading at a yield of 5.25%, what is implied volatility for the Chemtrade debenture conversion feature?

ii) You have just taken up a variable rate mortgage with a 25 year amortization at 4.15% (prime rate minus 80 bp). Assume that in one year the prime rate falls by 50 basis points. Calculate the amortization period remaining on the mortgage after the fall in the prime rate. (Provide the program/calculations used to arrive at the solution). If instead of falling, assume the prime rate increases. What is the 'trigger rate' on the mortgage, i.e., the rate at which the mortgage payment is all interest and further rate increases will require a reduction of principal. (For simplicity, can assume the rate increase occurs in one year. Be sure to show that the trigger rate results in no principal reduction).

3. Covered Interest Parity

Using the CME futures price quotes in the APPENDIX solve for the 3 and 6 month foreign interest rates implied by Covered Interest Parity using the 3 month SOFR futures as a proxy for the US interest rate and CME currency futures for the A$ and Mex$ (Mexican peso). (Hint: See the worked example on the class webpage; use the nearby contract for the spot price; final answers to be expressed as annualized interest rates. Easier to use the Dec. future as the nearby.)

4. CPP (Show Calculations, attach spreadsheet or mathematica code used to solve the problem)

The Canada Pension Plan (Canada Pension Plan, RSC 1985, c. C-8) is a complicated defined benefit plan that has several provisions, such as adjustments for 'drop-out years', that impact the required number of contribution years required to receive the maximum pension payment. In addition, the plan allows for pension payments to be started at any time between age 60 and age 70, with appropriate adjustment in the payment amount. For a female age 65 that is eligible for 3 years of 'drop-out provisions' that reduce the number of maximum contribution years to receive the full benefit, 38 qualifying years of maximum contributions are required for the full benefit of $17,196.00 per year ($1,433.00/mo.).

Using the maximum contribution amounts from the following Table and assuming investment returns applicable for each of the following intervals:

1984-1990	10.5%
1991-2000	7.5%
2001-2010	4.5%
2011-2024	3.25%

a) i) For both the employee and self-employed, calculate the amount that would have been earned (from 1984 to 2024) if the CPP contributions given in the Table below had been invested instead of being paid into CPP. (Hint: The calculation involves starting from 1984 and accumulating investment in a fund to arrive at a final total in 2024.)

Using the calculation from a) for both an employee and a self-employed individual that has made the maximum contributions detailed in the Table, solve the following (Note: as both the age 65 and age 70 amounts are indexed, increases in the payments over time can be ignored, i.e., the payment from age 65 and age 70 is given in 'constant dollars'):

ii) Assuming arithmetically declining survival rates and a maximum possible age of 93, calculate the implied interest for this individual electing to receive the maximum CPP pension payment at age 65 of $17,196.00 per year ($1,433.00/mo.). (Hint: This is the same type of calculation as that for Assignment #1, 2b)

b) i) For both the employee and self-employed, if the individual opts to defer taking the CPP until age 70 when the annual payment would be $1976.26/month; $23,715.15 annual (no further CPP contributions are required or made after 2024), calculate the implied interest rate assuming arithmetically declining survival rates and a maximum possible age of 93.

ii) At a current interest rate of 2.5% what is the breakeven age at which deferring CPP until age 70 has the same expected present value as taking CPP at age 65. (Hint: This involves using the cash flows from b) and c) above and doing a expected present value calculation for age 65.) How does your answer change if the interest rate is 5.5%? Would the answer change if, instead of arithmetically declining survival rates, the survival rates were calculated from a life table?

Table: Maximum Canada Pension Plan Contributions, 1984-2022

	Employee Contribution	**Self-Employment Contribution**
1984	$338.40	$676.80
1985	$379.80	$759.60
1986	$419.40	$838.80
1987	$444.60	$889.20
1988	dropout year	
1989	$525.00	$1050.00
1990	$574.20	$1148.40
1991	dropout year	
1992	$696.00	$1392.00
1993	$752.50	$1505.00
1994	$806.00	$1612.00
1995	$850.50	$1701.00
1996	dropout year	
1997	$993.22	$1996.44
1998	$1,068.80	$2,137.6
1999	$1,186.50	$2,373.00
2000	$1,329.90	$2,659.80
2001	$1,496.40	$2,992.80
2002	$1,673.20	$3,346.40
2003	$1,801.80	$3603.60
2004	$1,831.50	$3663.00
2005	$1,861.20	$3,722.40
2006	$1,910.70	$3821.40
2007	$1,989.90	$3979.80
2008	$2,049.30	$4,098.60
2009	$2,118.60	$4,337.20
2010	$2,163.15	$4,236.20
2011	$2,217.60	$4,435.20
2012	$2,306.70	$4,613.40
2013	$2,356.20	$4,712.40
2014	$2,425.50	$4,851.00
2015	$2,479.95	$4,959.90
2016	$2,544.30	$5,088.60
2017	$2,564.10	$5,128.20
2018	$2,593.80	$5,187.60
2019	$2,748.05	$5,497.80
2020	$2,898.00	$5,796.00
2021	$3,166.45	$6,332.90
2022	$3,499.80	$6,999.60
2023	$3,754.45	$7,508.90
2024	$4,034.10	$8,068.20

Source: https://www.canada.ca/en/revenue-agency/services/tax/businesses/topics/payroll/payroll-deductions-contributions/canada-pension-plan-cpp/cpp-contribution-rates-maximums-exemptions.html

APPENDIX FOR QUESTION #3 Quotes for Nov. 11, 2025

AUSTRALIAN DOLLAR FUTURES - SETTLEMENTS

TRADE DATE Tuesday, 11 Nov 2025

Last Updated 11 Nov 2025 11:55:00 PM CT

ESTIMATED VOLUME TOTALS 53,427 PRIOR DAY OPEN INTEREST TOTALS 179,467

MONTH	OPEN	HIGH	LOW	LAST	CHANGE	SETTLE	EST. VOLUME	PRIOR DAY OI
NOV 25	.65200	.65380B	.65160A	.65295A	-.00080	.65300	15	503
DEC 25	.65390	.65405	.65170	.65290B	-.00075	.65320	53,140	177,988
JAN 26	.65365	.65365	.65280A	.65365A	-.00075	.65335	2	108
FEB 26	-	-	-	.65215A	-.00075	.65345	0	0
MAR 26	.65405	.65430	.65210A	.65350A	-.00075	.65350	175	628
JUN 26	-	-	-	.65215A	-.00080	.65350	0	132
SEP 26	.65230	.65230	.65230	.65230A	-.00085	.65325	1	71
DEC 26	-	-	.65145A	.65145A	-.00085	.65265	0	20
MAR 27	.65230	.65260	.65080A	.65190B	-.00090	.65185	94	17
JUN 27	-	-	-	-	-.00090	.65105	0	0

MEXICAN PESO FUTURES - SETTLEMENTS

TRADE DATE Tuesday, 11 Nov 2025

Last Updated 11 Nov 2025 11:55:00 PM CT

ESTIMATED VOLUME TOTALS 41,091 **PRIOR DAY OPEN INTEREST TOTALS** 197,299

MONTH	OPEN	HIGH	LOW	LAST	CHANGE	SETTLE	EST. VOLUME	PRIOR DAY OI
NOV 25	-	.054520B	-	.054520B	+.000210	.054580	0	16
DEC 25	.054240	.054450	.054170	.054410	+.000200	.054420	41,086	197,157
JAN 26	-	.054160B	.054020A	.054020A	+.000200	.054240	0	2
FEB 26	-	-	-	-	+.000200	.054080	0	0
MAR 26	.053880	.053920B	.053660A	.053910A	+.000190	.053900	5	122
APR 26	-	-	-	-	+.000190	.053740	0	0
MAY 26	-	-	-	-	+.000200	.053550	0	0
JUN 26	-	-	-	-	+.000190	.053390	0	2
JLY 26	-	-	-	-	+.000190	.053230	0	0
AUG 26	-	-	-	-	+.000190	.053040	0	0

THREE-MONTH SOFR FUTURES - SETTLEMENTS

TRADE DATE Tuesday, 11 Nov 2025

Last Updated 11 Nov 2025 11:55:00 PM CT

ESTIMATED VOLUME TOTALS 1,063,460 **PRIOR DAY OPEN INTEREST TOTALS** 13,183,408

MONTH	OPEN	HIGH	LOW	LAST	CHANGE	SETTLE	EST. VOLUME	PRIOR DAY OI
AUG 25	-	-	-	-	+.0050	95.7725	0	9,116
SEP 25	95.9050	95.9075	95.9050	95.9075	+.0025	95.9075	10,448	1,364,053
OCT 25	96.0275	96.0275	96.0250	96.0250	+.0025	96.0300	122	10,337
NOV 25	96.1625	96.1650B	96.1625	96.1625B	+.0075	96.1625	3	3,644
DEC 25	96.2250	96.2550	96.2250	96.2450	+.0250	96.2500	216,126	1,417,618
JAN 26	-	96.3450B	-	96.3450B	+.0250	96.3400	0	2,031
FEB 26	-	96.4100B	-	96.4100B	+.0250	96.4050	0	360
MAR 26	96.4250	96.4750	96.4250	96.4650	+.0400	96.4650	133,579	1,213,147
APR 26	-	96.5400B	-	96.5400B	+.0400	96.5350	0	429
JUN 26	96.6500	96.7050	96.6450	96.6950	+.0450	96.6950	96,723	1,097,453
SEP 26	96.8000	96.8600	96.8000	96.8500	+.0500	96.8500	92,827	1,104,872

BONUS (2.5 points each)

a) Halley (1698) poses the following problem: An annuity of £40 being in possession for the term of 22 years, and for £80 paid down it can be prolonged for 10 years more to 32 years; what is the rate of interest required? (Hint: Evaluate the interest rate associated with paying £80 today for a cash flow of £40 that will last for 10 years after the 22 year annuity reaches maturity.)

b) Explain how to expand the function: $f[x] = \left(\frac{1}{1-x}\right)$

where the Taylor series is evaluated with an initial starting (fixed point) value of ¾. (Hint: evaluate the first second and third order expansions and provide an expression for the limiting solution.)