California Polytechnic State University, San Luis Obispo

Construction Management Department

CM 232, Evaluation of Cost Alternatives, Winter Quarter Section 03, 2020

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Office Hours:	Tuesday and Thursday 9:00 AM to 11:30 AM
Class Days/Times:	Monday and Tuesday 4:10 PM to 5:30 PM
Classroom:	186-B202
Prerequisite(s):	MATH 142 or MATH 182

Course Description

Basic principles of economic evaluations using fundamental concepts of time value of money to compare cost alternatives related to construction, design, and real property development. 3 lectures.

Course Goals and Learning Outcomes

Course Goals:

As a result of this course, you should be able to:

- To know and comprehend the basic principles of time value of money including the formulas and methods used to equate the value of financial alternatives that are available or selected at different points in time. (Learning Objectives #1 through #9 below.)
- To apply the basic principles of time value of money to the analysis of alternative cost proposals such as equipment purchase, materials selection, and project decisions – related to construction, engineering, and architecture. (Learning Objectives #10 through #18 below.)
- To apply the methods used in the analysis of alternative cost proposals to the evaluation of alternative investments – such as bonds, mortgages, and property improvements – common to construction, engineering, and architecture. (Learning Objectives #19 through #24 below.)

Course Learning Outcomes (CLOs):

1. Appreciate the role of engineering economy in making financial decisions in construction, design, and related areas of the built environment.
2. Perform calculations using simple and compound interest, the minimum attractive rate of return (MARR), and common cash flows.

3. Derive and use the common factors that relate present values, future values, uniform series, arithmetic gradients, and geometric gradients (F/P, P/F, A/F, F/A, A/P, P/A, P/G, and A/G) and linearly interpolate to determine an unknown value.
4. Describe and use the concept of financial equivalence in order to determine an unknown cash flow value given an interest rate and number of time periods.
5. Determine the interest rate – i - (or rate of return - IRR) for a sequence of cash flows or the number of time periods – n - required for equivalence in a cash flow series.
6. Perform basic time value of money calculations using both a financial calculator and an Excel spreadsheet.
7. Determine unknown cash flows, interest rates, or number of time periods for uniform and gradient series that start at times other than time period 1.
8. Calculate effective interest rates given nominal interest rates and an applicable compounding time period or for continuous compounding.
9. Make equivalence calculations for payment periods shorter than, equal to, or longer than the compounding period and for interest rates that vary over time.
10. Identify financial alternatives and select the best alternative based on a present worth analysis or a future worth analysis.
11. Determine the payback period of a financial alternative and perform a simple life-cycle cost analysis.
12. Explain how bonds are used to finance construction and development projects and calculate the present worth of a bond investment.
13. Identify financial alternatives and select the best alternative based on an annual worth analysis.
14. Calculate the annual worth of a permanent investment.
15. Perform a rate of return (ROR) analysis for a single financial alternative.
16. Perform an incremental rate of return (IROR) analysis to select the better of multiple financial alternatives and interpret the meaning of ROR on the incremental initial investment.
17. Develop Excel spreadsheets to complete analyses using present worth, future worth, annual worth, rate of return, and incremental rate of return.
18. Demonstrate the use of breakeven analysis for one or more financial alternatives to determine the level of activity necessary or the value of a parameter needed to “break even”.
19. Apply the commonly used depreciation methods when completing an engineering economy analysis.
20. Perform an economic evaluation of one or more financial alternatives considering the effects of income taxes and other pertinent tax regulations.
21. Apply the concepts of time value of money to mortgages used to finance construction and development projects to determine a uniform series of payments or other repayment alternatives
22. Develop an amortization schedule, including the impact of income and property taxes, and determine the payout amount at any given time and the amount of principal and the amount of interest paid to date.
23. Apply the principles of engineering economy to complete a simple pro forma analysis to determine the rate of return for a development proposal.
24. Expand the pro forma analysis for a development proposal to include a year to year after tax rate of return (YYATROR) and an overall after tax rate of return (OATROR).

Student and Program Learning Outcomes

The American Council for Construction Education (ACCE) is the accrediting body for Cal Poly's construction management program. The ACCE requires achievement of 20 student learning outcomes(SLOs). The construction management program has identified 20 program-learning outcomes (PLOs) that equal or exceed the ACCE SLOs and 5 additional idiosyncratic PLOs.

This course supports the following PLOs:

PLO 4: Create construction project cost estimates.
PLO 13: Understand construction risk management.
PLO 18: Understand the basic principles of sustainable construction.

An overview of content, course learning outcomes, program learning outcomes, instructional activities, and assessment measures, is listed in the table below.

Weeks	Topical Outline	CLOs	PLOs	Instructional Activities	Method of Assessment
1-4	Fundamentals and Net Present Value	1-9	4,13, 18	Lecture	Homework, quizzes and midterm No. 1
2-7	Annual worth and rate of return	10-18	4,13, 18	Lecture	Homework, quizzes and midterm No. 2
8-10	Pro forma evaluation – Taxes, mortgages, etc.	19-24	4, 13, 18	Lecture	Homework, quizzes and Final

Required Texts/Reading

Textbook

The Evaluation of Cost Alternatives, Custom Book published by Pearson (ISBN: 9781323924242) Available at the University Bookstore.

Additional material will be posted on Polylearn or handed out in class

Other Equipment/Material Requirements

Students must have a financial calculator capable of calculating IRR, NPV ("discounted cash flow"), present value, future value, interest payments, and mortgage payments. There are several brand names available ranging in price from around $30 to $120. I will use a Texas Instruments BA II Plus that is available at retail stores (such as Staples and the bookstore) for about $35 to $45. This is the model that I will be using in class to solve sample problems, so there are advantages to you using the same calculator, if you do not already own one. I strongly recommend that you use a financial calculator and do not try to get by with a scientific or general business calculator or an app on your phone. You will save lots of time. During exams, no device capable of internet access will be permitted.

Classroom Protocol

As a student, you are responsible to:

- Turn off cell phones and computers during lecture.
- There will be no socializing going on during lectures.
- Sleeping during class will not be tolerated.
- Do not read newspapers, books, do homework or additional class assignments during lectures. This can be distracting to the Professor as well as your fellow classmates
- Students will be responsible to keep the classroom clean during the quarter.
- Bikes are not allowed in the classroom.

Assignments and Exams

The following assignments and their associated point values are subject to change by the instructor as needed.

Description	**Points**
Homework and Participation	100
Quizzes	100
Midterm No. 1	100
Midterm No. 2	100
Final Exam	200
Total Points Possible	**600**

Late/Missed Work and Make-Up Policy

Late homework will not be accepted for grading except with excused absences with appropriate documentation. Please notify your professor as far in advance as possible for any planned absences.

Listed below is the grading scale for this course.

Letter Grade	**Percentage**	**Performance**	**Definition**
A	93 – 100%	Excellent Work	Superior Attainment of Course Learning Outcomes
A-	90 – 92%	Mostly Excellent Work	
B+	87 – 89%	Very Good Work	Good Attainment of Course Learning Outcomes
B	83 – 86%	Good Work	
B-	80 – 82%	Mostly Good Work	
C+	77 – 79%	Very Acceptable Work	Acceptable Attainment of Course Learning Outcomes
C	73 – 76%	Acceptable Work	
C-	70 – 72%	Mostly Acceptable Work	

Letter Grade	Percentage	Performance	Definition
D+	67 – 69%	Mostly Poor Work	Poor Attainment of Course Learning Outcomes
D	63 – 66%	Poor Work	
D-	60 – 62%	Very Poor Work	
F	0 – 59%	Failing Work	Non-Attainment of Course Learning Outcomes

University Policies

Participation and Attendance

Students are responsible for knowing the University policy regarding class attendance. See this link on Class Attendance Policy provided on the university website.

Add/Drop Policy

Students are responsible for knowing the University policies, procedures, and schedule for dropping or adding classes. See this link on Add/Drop Policy provided on the university website.

Academic Integrity

Students are responsible for knowing the Academic Honesty Policy.

Students with Disabilities

If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and the Disability Resource Center, Building 124, Room 119, at (805) 756-1395, as early as possible in the term, as accommodations may take several weeks to arrange. If you are a student with a disability, please consider discussing your needs and possible accommodations with me as soon as possible, and visit the DRC Website for additional information.

SensusAccess

SensusAccess is a self-service, alternate media solution made available by Kennedy Library to automatically convert files into a range of alternate media including audio books (MP3 and DAISY), e-books (EPUB, EPUB3 and Mobi) and digital Braille. The service can also be used to convert inaccessible files such as image-only PDF files, JPG pictures and Microsoft PowerPoint presentations into more accessible and less tricky formats. This service is available at no charge for all Cal Poly students, faculty, staff and alumni. For additional information, visit SensusAccess at the Kennedy Library.

Technical Support and Contact Information

Support is available for troubleshooting and access issues for PolyLearn. Please visit the PolyLearn Student Support Web Site for further information.

Campus Resources to Support Student Learning

Cal Poly offers programs and resources that are available to assist students during your academic studies, such as the Cal Poly Student Academic Services Web Site.

COURSE POLICIES

Laptop Policy

The department has a requirement that all students have a notebook computer. Most Construction Management classes emphasize cooperative projects/assignments, and a notebook computer provides the required mobility to facilitate collaboration. In today's construction environment, computing is an integral component with the computer being the standard tool. A notebook computer is the key to having computing capability available at all times and all locations. Financial aid may be available to cover the cost of the computer laptop. Go to the Cal Poly Financial Aid Office website http://financialaid.calpoly.edu/ for more information. For more detailed information about laptop specifications see the CM website. (http://www.construction.calpoly.edu/content/prospective/laptop-requirements)

Other Polices

Homework Submission Policy:

Homework due dates are shown on the schedule. Homework from the textbook will be graded on a basis of neatness, adherence to proper format (example included), honest attempt, and accuracy. There will be Nineteen assignments, each worth 5 points. 2 points will be allotted for correct work / answers. Three points will be allotted for neatness, proper format, and attempt of each problem. As long as you turn in a neat paper with an attempt for each problem, you will receive at least a passing grade for that assignment.

Engineering Paper must be used. Any brand will do.

Heading must consist of: "Last Name, First name" followed by the course "CM 232", then the date, followed by the assignment number. Finally, on the right hand portion of the page, page numbers should be given with the current page over total pages.

Problems must be worked top to bottom on one side of the paper. Do not work problems left to right, or multiple problems side by side. Problem numbers should be clearly identified on the left hand side of the page. Work, including starting equations, must be shown. Simple arithmetic may be omitted. Do not round values until the end. Round answers over $1,000 to the nearest dollar. Answers less than $1,000 should be rounded to the tens place (i.e. $521.97). Percent answers should be rounded to the nearest hundredth of a percent (i.e. 15.99%). At a minimum, all steps of every problem should be calculated and reported to at least four significant figures. Answers should be clearly boxed.

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Week	Date	Topics	Readings,	Homework
1	Jan 6	• Course Introduction • Time value of money • Elements of transactions • Methods of calculating interest	Syllabus Chapter 1 Time Value of money Sections 1.0-1.3	HW Chapter 1 Problems 7, 8, and 9 HW 1 -Due 1/8
	Jan 8*	• Definition and simple calculation • Equivalence calculations	Chapter 1 Time Value of money Sections 2.0 & 2.1	HW Chapter 1 Problems 10, 14, 15, 19, and 21 HW 2 - Due 1/13
2	Jan 13*	• Compound amount factor • Present worth factors • Solving for time and interest rates • uneven payment series Quiz No. 1	Chapter 1 Time Value of money Sections 3.1,3.2, and 4.0	HW Chapter 1 Problems 24, 25, 27, 28, and 29 HW 3- Due 1/15
	Jan 15*	• Compound amount factor • Sinking fund factor • Capital recovery factor • Present worth factor • Present worth of perpetuities	Chapter 1 Time Value of money Sections 5.1-5.5	HW Chapter 1 Problems 33, 35, 38, 41, and 45 HW 4 - Due 1/21
3	Jan 20 Holiday Jan 21 Monday Schedule	• Handling linear gradient series • Handling geometric series Quiz No. 2	Chapter 1 Time Value of money Sections 6.1 & 6.2	HW Chapter 1 Problems 48, 52, 54 part a, and 56 HW 5 - Due 1/22

Week	Date	Topics	Readings,	Homework
	Jan 22*	• Nominal interest rates • Effective interest rates • Discrete compounding • Continuous compounding	Chapter 2 Understanding money management Section 1.1, 1.2, and 2.2	HW Chapter 2 Problems 2, 10, 13, 24, and 36 HW 6 Due 1/27
4	Jan 27*	• Loan versus Project Cash flow • Benefits and flaws of payback screening • Net present worth criterion • Capitalized Equivalent method Quiz No. 3	Chapter 3 Present Worth Analysis Sections 1.0,2.1,3.1,3.5 +handout on discounted payback	HW Chapter 3 Problems 4, 5 8,10, 11, and 13 HW 7- Due 1/29
	Jan 29*	• Do Nothing is a decision • Service projects versus revenue projects • Analysis period equals project lives • Analysis period differs from project lives	Chapter 3 Present Worth Analysis Sections 4.1-4.4	HW Chapter 3 Problems 14, 25, 27, 31 part a, and 32 HW 8- Due 2/3
5	Feb 3*	• Annual equivalent worth criterion • Benefits of AE analysis • Capital (ownership) versus operating costs • Applying Annual –worth analysis • Unit profit or unit cost calculation • Make of buy decision	Chapter 4 - Annual Equivalence Analysis Sections 1.0-1.2, and 2.0-2.2	HW Chapter 4 Problems 2, 3, 4, 7 and 8 HW 9- Due 2/5
	Feb 5*	EXAM No. 1 - Chapter 1, 2 and 3 Time value of Money, Money Management and Net present worth		Case Study Assignment No. 1 Due 2/10

Week	Date	Topics	Readings,	Homework
6	Feb 10	• comparing mutually exclusive projects • Analysis period equal project lives	Chapter 4 - Annual Equivalence Analysis Sections 3.0 & 3.1	HW Chapter 4 Problems 11, 14, 17, 22, and 30 HW 10- Due 2/12
	Feb 12*	• Rate of Return • Return on Investment • Return on Invested capital • Methods for finding rate of return • Simple versus non-simple investments	Chapter 5 Rate of Return Analysis Sections 1.0-1.2, and 2.0	HW Chapter 5 Problems 2, 4, 6, 8, and 11 HW 11 – Due 2/19
7	Feb 17 *	HOLIDAY		
	Feb 19*	• Relationship with PW analysis • Internal rate of return criterion • Decision rules for simple investments Quiz No. 4	Chapter 5 Rate of Return Analysis Sections 3.0-3.2	HW Chapter 5 Problems 14 part a, 16, 17, 24 part a, 25 part a HW 12 Due2/24
8	Feb 24*	• Incremental analysis for comparing mutually exclusive alternatives • Flaws in project raking by IRR • Incremental investment analysis • Handling unequal service lives	Chapter 5 Rate of Return Analysis Sections 4.0-4.3	HW Chapter 5 Problems 32, 35, 41, 42, and 44 HW 13 Due 2/26
	Feb 26*	EXAM No 2 - Chapters 4 and 5 Annual worth and Rate of Return Analysis		Case study Assignment No. 2 Due 3/2

Week	Date	Topics	Readings,	Homework
9	Mar 2*	• Commercial loans (mortgages) • Fixed Interest Rate Mortgage	Chapter 2 Section 4.2 and Handout	HW 14 problems posted in Polylearn HW 14 Due 3/4
	Mar 4*	• Useful life and Salvage Value • Depreciation methods book and tax depreciation • Book Depreciation methods • Declining Balance method • Straight line Method • Corporate taxes • US corporate income tax system • Gain taxes on asset disposals • Depreciable property	Chapter 6 Accounting for depreciation Sections 1.0-1.4, Sections 2.0-2.2 Sections 4.0-4.3	HW Chapter 6 Problems 1, 7, 8, 15, 28, , 42 part a and c, HW 15 due 3/9
10	Mar 9*	• Sensitivity Analysis • Sensitivity Analysis for mutually exclusive alternatives • Break even analysis Quiz No. 5	Chapter 7 Handling Project uncertainty Section 2.1-2.3	HW Chapter 7 Problems 1 part a, 3, 5 part a, 10, 12 HW 16 Due 3/11
	Mar 11*	• Pro forma Analysis on Case study of the development opportunities	Handout	HW 17 Due with final exam
Final Exam	Finals Week TBD*	Bldg. 186 – B202		

*Indicates dates with homework due

1.14 $P = \$1,600,000$

a) $F = \$1,600,000\ (1.10)(1.10)$

$\boxed{F = \$1,936,000 \text{ @EOY2}}$

b) $I = \$1,936,000 - \$1,600,000$

$\boxed{I = \$336,000}$

1.15

$$\text{RATE} = \frac{\text{INTEREST}}{\text{ORIG. AMNT}}(100\%)$$

$$= \frac{\$420,000}{\$2,000,000}(100\%)$$

$\boxed{\text{RATE} = 21\%/\text{YR}}$

1.16

$\text{TOTAL} = \text{ORIG. AMNT} + \text{ORIG. AMNT (RATE)}$

$\$82,000,000 = A_0(1+0.08)$

$$A_0 = \frac{\$82,000,000}{1.08}$$

$\boxed{\text{ORIG. AMNT} = \$75,925,926}$