Engineering Economic Analysis Mid-Term Exam, F2024

Course Code IEM 3503 **Course Name** EEA

Time allowed 120 minutes

NO.	1	2	3	4	5	6	7	8	9	10	**Score**
Pts											

Instructions:

*Please attempt every problem. You must support every solution with an appropriate amount of work and/or description. Unsupported answers may receive a score of 0. The total is **100** points. Good luck !*

1. (12 pts) Decide if the following statement is True or False.

(a) If two cash flows occur in different periods, you can compare their values directly without adjusting for the interest rate, as long as the amounts are the same.

False +2

(b) A dollar received five years from now is always worth more than a dollar received today if interest rates are negative.

True +2

(c) Investments should always be made if they have the potential to generate any positive return, regardless of their economic justification.

False +2

(d) A company should continue to invest as long as each incremental investment yields a return greater than the company's time value of money (TVOM).

True +2

(e) When comparing different investment alternatives, it is necessary to consider the common time period for all options.

True +2

(f) A company should consider past costs in their analysis of future investments if those costs do not directly impact future cash flows.

False +2

Name

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School

Sealing line

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2. (10 pts) If your TVOM is 6% and your colleague's is 8%, can the two of you agree on mutually satisfactory terms for a 1-year, $2,000 loan? Assume that the lender has the money available and neither of you wants to go outside your acceptable TVOM range. Be explicit about who is lending and what is the acceptable range of money paid back on the loan.

Solution:

- Step 1: Identify the lender and the borrower.
  In this scenario, you are the lender because your TVOM (6%) is lower than your colleague's (8%). +2

- Step 2: Your perspective as the lender (6% TVOM).
  Calculate the future value (FV) of the loan you expect to receive after one year:

  $$FV_{you} = PV \times (1 + r) = 2000 \times (1 + 0.06) = \$2120.$$

  Thus, you would expect to receive $2,120 at the end of the year. +3

- Step 3: Colleague's perspective as the borrower (8% TVOM).
  Calculate the maximum amount they are willing to pay back:

  $$FV_{colleage} = PV \times (1 + r) = 2000 \times (1 + 0.08) = \$2160.$$

  Thus, your colleague would be willing to pay back a maximum of $2,160 at the end of the year. +3

- Establish the range of acceptable repayment amounts.
  The range of mutually satisfactory repayment terms lies between $2,120 and $2,160. +2

3. (8 pts) Four proposals (A, B, C, and D) are available for investment. At least two must be chosen. Proposals A and C cannot both be accepted; Proposal B is contingent upon the acceptance of either Proposal C or D; and Proposal A is contingent on D. List all feasible mutually exclusive investment alternatives.

Solution:

Since at least 2 must be selected. The list of all possible combinations are given below:

$$AB, AC, AD, BC, BD, CD, ABC, ABD, BCD, ABCD.$$

+3

Since A and C can't be both accepted, the following combinations will be excluded:

$$AC, ABC, ABCD.$$

Since B is contingent upon either C or D, the following combinations will be excluded

$$AB.$$

.

Finally, A is contingent on D, the following combinations will be excluded

$$AB, AC, ABC.$$

Hence the list of all feasible mutually exclusive investment alternatives are

$$AD,\ BC,\ BD,\ CD,\ ABD, BCD.$$

+5

4. (6 pts) Suppose you invest $5,000 in a project that pays a compound interest rate of 8% per year. At the end of 1 year, the project generates enough revenue to reinvest the initial amount plus interest earned. This process continues for a total of 4 years. How much will your investment be worth at the end of 4 years with compound interest? What if the interest rate were a simple one?

Solution:

With a compound interest rate of 8%, the future worth of your investment at the end of 4 years is

$$F = P(1 + i)^n = 5000(1 + 0.08)^4 = 6802.50.$$

+3

If the interest rate were a simple one, the future worth of your investment at the end of 4 years is

$$F = P + P \times i \times n = 5000 + 5000 \times 0.08 \times 4 = 6600.$$

+3

5. (10 pts) The manager at a Sherwin-Williams store has decided to purchase a new \$30,000 paint mixing machine with high-tech instrumentation for matching color and other components. The machine may be paid for in one of two ways: (1) pay the full price now with a 3% discount, or (2) pay \$5,000 now, \$8,000 one year from now, and \$12,000 at the end of each of the next 2 years. If interest is 12% compounded annually, determine which way is best for the manager to make the purchase.

Solution:

Let's compare the present values of these two ways of payments.

- For the first way, the present value of the payment with a 3% discount is

$$P_1 = 30,000(1 - 0.03) = 29100.$$

+3

- For the second way, the present value of the payments is

$$P = 5000+8000(1+0.12)^{-1}+12000(1+0.12)^{-2}+12000(1+0.12)^{-3} = 30250.54665.$$

+5

Since the first way has a smaller present value, it is best for the manager to make the purchase now with a 3% discount. +2

6. (12 pts) You have $20,000 that you put on deposit on your 30th birthday at 5% compounded annually. On your 40th birthday, the account begins earning 6%. Then, on your 50th birthday it begins earning 7% and the interest rate stays at 7% thereafter. You plan to withdraw equal annual amounts on each of your 61st, 62nd, . . . , 70th birthdays.

   (a) How much will be your annual withdrawal?

   (b) On your way to the bank on your 65th birthday, you decide to withdraw the entire amount remaining. How much do you withdraw?

Solution:

The amount in the account at your 60th birthday is

$$F_{60} = 20000(1+0.05)^{10}(1+0.06)^{10}(1+0.07)^{10} = 114,767.6307.$$

+3

(a) The 10 equal annual withdrawals have a worth of F_{60} at your 60th birthday. Hence, the annual amount is

$$A = F_{60}\frac{0.07((1+0.07)^{1}0}{(1+0.07)^{10}-1} = 16340.329.$$

+4

(b) The amount should be the worth of the last 6 withdrawals at the 65th birthday, which is the sum of the 5th withdrawal and the worth of the last 5 withdrawals at the 65th birthday. That is,

$$16340.329 + 16340.329\frac{(1+0.07)^5-1}{0.07(1+0.07)^5} = 83338.90228.$$

+5

7. (10 pts) A series of 10 end-of-year deposits is made that begins with \$10,000 at the end of year 1 and decreases at the rate of \$1000 per year with 10% interest.

   (a) What amount could be withdrawn at $t = 10$ right after the 10th deposit?

   (b) What uniform annual series of deposits (n = 10) would result in the same accumulated balance at the end of year 10.

Solution:

(a) The composite series consists of a uniform series with $A_t = A_1 = 10000$ for $t = 1, 2, \ldots 10$ and a gradient series with $G = -1000$. Hence the amount could be withdrawn at $t = 10$ right after the 10th deposit is

$$\begin{aligned} F_c &= F_u + F_g \\ &= 10000\frac{(1+0.1)^{10}-1}{0.1} - 1000\frac{(1+0.1)^{10}-(1+10\times 0.1)}{0.1^2} \\ &= 100000 \end{aligned}$$

+5

(b) Since the uniform annual series results in the same accumulated balance, the annual deposit should be

$$A = 100000\frac{0.1}{(1+0.1)^{10}-1} = 6274.539.$$

+5

8. (10 pts) An easy payment plan offered by a local electronics store for your new audio system calls for end-of-year payments of \$2,000 at the end of year 1, increasing by 15% each year thereafter through year 4. Your money is well invested and earns a consistent 10% per year.

   (a) What is the present worth of these payments?

   (b) If you prefer to make equal annual payments having the same present worth, how much would they be?

   Solution:

   (a) The payments forms a geometric series of cash flows with

   $$A_1 = 2000,\ j = 0.15,\ i = 0.1,\ n = 4$$

   . Hence the present worth of these payments is

   $$P = 2000\frac{1-(1+0.15)^4(1+0.1)^{-4}}{0.1-0.15} = \$7783.792$$

   +5

   (b) Since the uniform annual series has the same present worth, the annual deposit should be

   $$A = 7783.792\frac{0.1(1+0.1)^4}{(1+0.1)^4-1} = \$2455.559.$$

   +5

9. (15 pts) Wei Min opens a retirement account that pays 8%/year compounded monthly. For the next 30 years he deposits \$300 per month into it, with all deposits occurring at the end of the month. On the day of the last deposit, Wei Min retires. As a benefit to retirees, the bank increases the interest rate to 12%/year compounded quarterly from that time on. His first withdrawal will occur exactly 2 years after his last deposit. He then plans to make equal quarterly withdrawals from the account.

   (a) What is the balance of the account immediately after the last monthly deposit?

   (b) What is the balance of the account one quarter before the first quarterly withdrawal?

   (c) What quarterly amounts can be withdrawn to last for 15 years?

Solution:

(a) The monthly interest rate is $i_m = 0.08/12 = 1/150$. The number of deposits over the next 30 years is $n_m = 30 \times 12 = 360$. Hence the balance of the amount immediately after the last monthly deposit is

$$F = 300\frac{(1+1/150)^{360}-1}{1/150} = 447,107.8345.$$

+5

(b) The quarterly interest rate after he retires is $i_q = 0.12/4 = 0.03$. One quarter before the first quarterly withdrawal is exactly 7 quarters after the last deposit. Hence the balance of the account one quarter before the first quarterly withdrawal is

$$P_q = 447,107.8345(1+0.03)^7 = 549886.2407.$$

+5

(c) For the equal quarterly withdrawals to last for 15 years, we have $n_q = 15\times 4 = 60$ quarterly withdrawals. Hence the quarterly amount is

$$A_q = 549886.2407\frac{0.03(1+0.03)^{60}}{(1+0.03)^{60}-1} = \$19869.0168.$$

+5

10. (7 pts)

(a) A total of \$10,000 is borrowed and repaid with 30 monthly payments, with the first payment occurring one month after receipt of the \$10,000. The stated interest rate is 6% compounded quarterly. What monthly payment is required?

Solution:

The monthly interest rate is

$$i_m = (1 + 0.06/4)^{4/12} - 1 = 0.004975.$$

+2

Hence the monthly payment is

$$A_m = 10000\frac{0.004975(1 + 0.004975)^{30}}{(1 + 0.004975)^{30} - 1} = 359.654.$$

+2

(b) What amount must be placed on deposit today to equal \$10,000 in 4 years at 15% per year compounded continuously?

Solution:

The effective annual interest rate is

$$i_{eff} = e^{0.15} - 1 = 0.161834.$$

+2

Hence the monthly payment is

$$P = 10000(1 + 0.161834)^{-4} = \$5488.116.$$

+1