

IE 400 Fall 2019 Study Set 4

1) You and several friends are about to prepare a lasagna dinner. The tasks to be performed, their immediate predecessors and their estimated durations are as follows:

Task	Description	Predecessor	Time (minutes)
A	Buy the mozzarella cheese	-	30
B	Slice the mozzarella	A	5
C	Beat 2 eggs	-	2
D	Mix eggs and ricotta cheese	C	3
E	Cut up onions and mushrooms	-	7
F	Cook the tomato sauce	E	25
G	Boil water	-	15
H	Boil the lasagna noodles	G	10
I	Drain the lasagna noodles	H	2
J	Assemble all ingredients	B, D, F, I	10
K	Preheat the oven	-	15
L	Bake the lasagna	J,k	30

- Construct the project network and find the critical path for preparing this dinner.
- Find the earliest start time, earliest finish time, latest start time, latest finish time and the slack for each activity.
- Because of a phone call, you were interrupted for 6 minutes when you should have been cutting the onions and mushrooms. By how much will the dinner be delayed? If you use your food processor, which reduces the cutting time from 7 to 2 minutes, will the dinner still be delayed?
- Formulate an LP model that would give the latest start time of activities without delaying the dinner.

2) You are about to borrow \$10,000 from a bank at an interest rate of 9% compounded annually. You are required to make five equal annual repayments in the amount of \$2,571 per year, with the first repayment occurring at the end of year 1. Show the interest payment and principal payment in each year.

3) How much invested now at 6% would be just sufficient to provide three payments, with the first payment in the amount of \$7,000 occurring two years hence, then \$6,000 five years hence, and finally \$5,000 seven years hence?

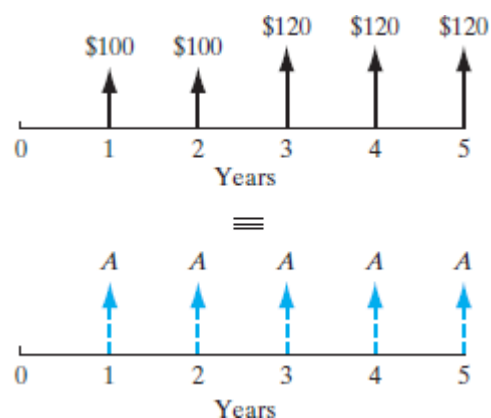
4) Consider the list of activities and predecessors that are involved in a house construction.

Activity	Description	Immediate Predecessor	Duration (days)	Crashing cost per day	Max possible reduction in duration
A	Foundation	-	5	30	2
B	Walls and Ceiling	A	8	15	3
C	Roof	B	10	20	1
D	Electrical Wiring	B	5	40	2
E	Windows	B	4	20	2
F	Siding	E	6	30	3
G	Paint	C,F	3	40	1

- Draw a project network, determine the critical path and project duration (without considering crashing)
- Which activities can be delayed without delaying the entire project?
- Suppose that by hiring additional workers, the duration of each activity can be reduced. The costs per day of reducing the duration of activities are given in the table above. Write down the LP that minimizes the total cost of completing the project within 20 days.

5) You bought 300 shares of Microsoft (MSFT) stock at \$2,600 on December 31, 2005. Your intention is to keep the stock until it doubles in value. If you expect 15% annual growth for MSFT stock, how many years do you anticipate holding onto the stock?

6) What value of A makes two annual cash flows equivalent at 13% interest compounded annually?



- 7) A repair shop needs a machine for the next 5 years. A new machine cost \$1,000. The cost m_i of maintaining an engine during its i^{th} year of operation is as follows:
 $m_1 = \$60, m_2 = \$80, m_3 = \$120$. A machine may be kept up to 3 years; after i years of use ($i = 1, 2, 3$), it may be traded in for a new one. If i -year-old engine is traded in, a salvage value s_i is obtained. ($s_1 = \$800, s_2 = \$600, s_3 = \$500$)

Given that a new machine must be purchased now, the repair shop wants to determine a replacement and trade-in policy that minimizes net costs during the next 5 years. Solve this problem using dynamic programming.

(Net costs = Maintenance costs + Replacement costs - Salvage value received)

8)

Give a dynamic programming model for the following integer problem:

$$\begin{aligned}
 \max \quad & \sum_{j=1}^n c_j x_j \\
 \text{s.t.} \quad & \sum_{j=1}^n a_j x_j \leq b_1 \\
 & \sum_{j=1}^n d_j x_j \leq b_2 \\
 & x_j \geq 0 \quad \forall j \text{ and integer}
 \end{aligned}$$

