

Q. 1. (1.5 point) Consider the list of activities and predecessors that are involved in building a house.

Activity	Description	Immediate Predecessors	Duration (days)	Crashing cost per day	Max possible reduction in duration of activity
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

Q. 2. (1 point) The promoter of a Mayfest concert in Bilkent must perform the tasks shown in Table before the concert can be held(all durations are in days)

Activity	Description	Immediate Predecessors	a	b	m
A	Find site	—	2	4	3
B	Find engineers	A	1	3	2
C	Hire opening act	A	2	10	6
D	Set radio and TV ads	C	1	3	2
E	Set up ticket agents	A	1	5	3
F	Prepare electronics	B	2	4	3
G	Print advertising	C	3	7	5
H	Set up transportation	C	0.5	1.5	1
I	Rehearsals	F, H	1	2	1.5
J	Last-minute details	I	1	3	2

Find the probability that concert can be held on 15th day or before. Show all your work clearly.

Q. 3. (2.5 point) A company is planning to manufacture a product that consists of three parts (A, B, and C). The company anticipates that it will take 5 weeks to design the three parts and to determine the way in which these parts must be assembled to make the final product. Then the company estimates that it will take 4 weeks to make part A, 5 weeks to make part B, and 3 weeks to make part C. The company must test part A after it is completed (this takes 2 weeks). The assembly line process will then proceed as follows: assemble parts A and B (2 weeks) and then attach part C (1 week). Then the final product must undergo 1 week of testing. Draw the project network, find the critical path and free float for each activity. Also set up an LP that could be used to find the critical path.

Q. 4. (2.5 point) A student taking three courses (A, B and C) wants to minimize the probability of failing all three courses. Suppose that s/he has 4 hours per week on studying. The probability of failing/passing each course depends on the number of hours s/he spends studying for the course (see Table). Use dynamic programming to determine how many hours per week the student should spend studying each course. Define stages, states and recursive function clearly. What is the optimal solution and optimal value ?

Hours of Study per Week	Probability of Failing Course		
	A	B	C
0	0.8	0.75	0.9
1	0.7	0.7	0.7
2	0.65	0.67	0.6
3	0.62	0.65	0.55
4	0.6	0.62	0.5

Q. 5. (2.5 point) The owner of a lake must decide how many fish to catch and sell at the beginning of each year. Assume that the market demand for fish is unlimited. If x is the fish sold in year n , a revenue of $r_n(x)$ is earned. The cost to catch x fish in year n is $c_n(x, b)$, where b is the number of fish in the lake at the beginning of the year n . The number of fish in the lake at the beginning of the year is the double of the number in the lake at the end of the previous year. The owner is interested in maximizing the overall profit over the next n years. a) Formulate the problem as a DP model. b) Solve the problem for $n = 3$ years, $r_1(x) = 10x$, $r_2(x) = 13x$, $r_3(x) = 12x$. The cost of catching $c_1(x) = 2x$; $c_2(x) = 4x$; $c_3(x) = x$ (it does not depend on the number of fish in the lake). Currently there are 10 fish in the lake.