1. The manufacturing process of a product consists of two successive operations, I and II. The following table provides the pertinent data over the months of June, July, and August:

	June	July	August
Finished product demand (units)	500	450	600
Capacity of operation I (hr)	800	700	550
Capacity of operation II (hr)	1000	850	700

Producing a unit of the product takes .6 hr on operation I plus .8 hr on operation II. Overproduction of either the semi-finished product (operation I) or the finished product (operation II) in any month is allowed for use in a later month. The respective holding costs for operations I and II are \$.20 and \$.40 per unit per month. The production cost varies by operation and by month. For operation 1, the unit production cost is \$10, \$12, and \$11 for June, July, and August. For operation 2, the corresponding unit production cost is \$15, \$18, and \$16.
Develop an LP model to determine the optimal production schedule for the two operations over the 3-month horizon.

2. On most U.S. university campuses, students are contracted by academic departments to do errands, such as answering the phone and typing. The need for such service fluctuates during work hours (8:00 a.m. to 5:00 p.m.). In one department, the minimum number of students needed is 2 between 8:00 a.m. and 10:00 a.m., 4 between 10:01 a.m. and 11:00 a.m., 3 between 11:01 a.m. and 1:00 p.m., and 2 between 1:01 p.m. and 5:00 p.m. Each student is allotted 3 consecutive hours (except for those starting at 3:01, who work for 2 hours, and those who start at 4:01, who work for 1 hour). Because of their flexible schedule, students can usually report to work at any hour during the workday, except that no student wants to start working at lunch time (12:00 noon). Develop the LP model and determine a time schedule specifying the time of the day and the number of students reporting to work.

3. An oil company distills two types of crude oil, A and B, to produce regular and premium gasoline and jet fuel. There are limits on the daily availability of crude oil and the minimum demand for the final products. If the production is not sufficient to cover demand, the shortage must be made up from outside sources at a penalty. Surplus production will not be sold immediately and will incur storage cost. The following table provides the data of the situation:

	Fraction Yield per bbl				
Crude	**Regular**	**Premium**	**Jet**	**Price/bbl (\$)**	**Bbl/day**
Crude A	0.2	0.1	0.25	30	2500
Crude B	0.25	0.3	0.1	40	3000
Demand (bbl/day)	500	700	400		
Revenue (\$/bbl)	50	70	120		
Storage cost for surplus production (\$/bbl)	2	3	4		
Penalty for unfilled demand (\$/bbl)	10	15	20		

Develop an LP model to determine the optimal product mix for the refinery.

4. A city will undertake five urban renewal housing projects over the next 5 years. Each project has a different starting year and a different duration. The following table provides the basic data of the situation:

	Year1	Year2	Year3	Year4	Year5	Cost **(million $)**	Annual income **(million $)**
Project1	Start		End			5.0	0.05
Project2		Start			End	8.0	0.07
Project3	Start				End	15.0	0.15
Project4			Start	End		1.2	0.02
Budget (million $)	3.0	6.0	7.0	7.0	7.0		

Projects 1 and 4 must be finished completely within their durations. The remaining two projects can be finished partially within budget limitations, if necessary. However, each project must be at least 25% completed within its duration. At the end of each year, the completed section of a project is immediately occupied by tenants, and a proportional amount of income is realized. For example, if 40% of project 1 is completed in year 1 and 60% in year 3, the associated income over the 5-year planning horizon is .4 * $50,000 (for year 2) + .4 * $50,000 (for year 3) + (.4 + .6) * $50,000 (for year 4) + (.4 + .6) * $50,000 (for year 5) = (4 * .4) + (2 * .6) * $50,000.Develop an LP model to determine the schedule for the projects that will maximize the total income over the 5-year horizon.