Problem F

The Weedwacker Company manufactures two types of lawn trimmers: an electric model and a gas model. The company has contracted to supply a national discount retail chain with a total of 30,000 electric trimmers and 15,000 gas trimmers. However, Weedwacker's production capability is limited in three departments: production, assembly, and packaging. The following table summarizes the hours of processing time available and the processing time required by each department, for both types of trimmers:

	Hours Required per Trimmer		
	Electric	Gas	Hours Available
Production	0.20	0.40	10,000
Assembly	0.30	0.50	15,000
Packaging	0.10	0.10	5,000

The company makes its electric trimmer in-house for $55 and its gas trimmer for $85. Alternatively, it can buy electric and gas trimmers from another source for $67 and $95, respectively. How many gas and electric trimmers should Weedwacker make and how many should it buy from its competitor in order to fulfill its contract in the least costly manner?

Problem G

A furniture manufacturer produces two types of tables (country and contemporary) using three types of machines. The time required to produce the tables on each machine is given in the following table.

Machine	Country	Contemporary	Total Machine Time Available per Week
Router	1.5	2.0	1,000
Sander	3.0	4.5	2,000
Polisher	2.5	1.5	1,500

Country tables sell for $350 and contemporary tables sell for $450. Management has determined that at least 20% of the tables made should be country and at least 30% should be contemporary. How many of each type of table should the company produce if it wants to maximize its revenue?

Problem H

A hospital dietitian prepares breakfast menus every morning for the hospital patients. Part of the dietitian's responsibility is to make sure that minimum daily requirements for vitamins A and B are met. At the same time, the cost of the menus must be kept as low as possible. The main breakfast staples providing yitamins A and B are eggs, bacon, and cereal. The vitamin requirements and vitamin contributions for each staple follow:

	Vitamin Contributions			
Vitamin	mg/Egg	mg/Bacon Strip	mg/Cereal Cup	Minimum Daily Requirements
A	2	4	1	16
B	3	2	1	12

An egg costs \$0.04, a bacon strip costs \$0.03, and a cup of cereal costs \$0.02. The dietitian wants to know how much of each staple to serve per order to meet the minimum daily vitamin requirements while minimizing total cost.

Solve the problem using a set-based AMPL model.

Value of objective function in optimal solution: 0.17

Problem I

The Pyrotec Company produces three electrical products—clocks, radios, and toasters. These products have the following resource requirements:

	Resource Requirements	
	Cost/Unit	Labor Hours/Unit
Clock	\$ 7	2
Radio	10	3
Toaster	5	2

The manufacturer has a daily production budget of \$2,000 and a maximum of 660 hours of labor. Maximum daily customer demand is for 200 clocks, 300 radios, and 150 toasters. Clocks sell for \$15, radios for \$20, and toasters for \$12. The company wants to know the optimal product mix that will maximize profit.

Solve the problem using a set-based AMPL model.

Value of objective function in optimal solution: 2478.57

Problem J

Consider the following transportation problem:

	To (cost)			
From	1	2	3	Supply
A	$ 6	$ 9	$100	130
B	12	3	5	70
C	4	8	11	100
Demand	80	110	60	

Solve the problem using a set-based AMPL model.

Value of objective function in optimal solution: 1530

Problem K

Solve the following problem using a set-based AMPL model:

minimize $Z = 3x_{11} + 12x_{12} + 8x_{13} + 10x_{21} + 5x_{22} + 6x_{23} + 6x_{31} + 7x_{32} + 10x_{33}$

subject to

$$\begin{aligned} x_{11} + x_{12} + x_{13} &= 90 \\ x_{21} + x_{22} + x_{23} &= 30 \\ x_{31} + x_{32} + x_{33} &= 100 \\ x_{11} + x_{21} + x_{31} &\leq 70 \\ x_{12} + x_{22} + x_{32} &\leq 110 \\ x_{13} + x_{23} + x_{33} &\leq 80 \\ x_{ij} &\geq 0 \end{aligned}$$

Value of objective function in optimal solution: 1240

Problem L

Bayville has built a new elementary school, increasing the town's total to four schools—Addison, Beeks, Canfield, and Daley. Each has a capacity of 400 students. The school board wants to assign children to schools so that their travel time by bus is as short as possible. The school board has partitioned the town into five districts conforming to population density—north, south, east, west, and central. The average bus travel time from each district to each school is shown as follows:

	Travel Time (min.)				
District	Addison	Beeks	Canfield	Daley	Student Population
North	12	23	35	17	250
South	26	15	21	27	340
East	18	20	22	31	310
West	29	24	35	10	210
Central	15	10	23	16	290

a) Determine the number of children that should be assigned from each district to each school to minimize total student travel time.

Value of objective function in optimal solution: 20700 (14,79 per student)

b) The school board has determined that it does not want any of the schools to be overly crowded compared with the other schools. It would like to assign students from each district to each school so that enrollments are evenly balanced between the four schools. However, the school board is concerned that this might significantly increase travel time. Determine the number of students to be assigned from each district to each school such that school enrollments are evenly balanced. Does this new solution appear to significantly increase travel time per student?

Value of objective function in optimal solution: 21200 (15,14 per student)

Problem M

World Food, Inc., imports food products such as meats, cheeses, and pastries to the United States from warehouses at ports in Hamburg, Marseilles, and Liverpool. Ships from these warehouses deliver products to Norfolk, New York, and Savannah, where they are stored in company warehouses before being shipped to distribution centers in Dallas, St. Louis, and Chicago. The products are then distributed to specialty food stores and sold through catalogs. The shipping costs from the European ports to the U.S. cities and the available supplies at the European ports are provided in the following table:

	U.S. City			
European Port	4. Norfolk	5. New York	6. Savannah	Supply
1. Hamburg	$420	$390	$610	55
2. Marseilles	510	590	470	78
3. Liverpool	450	360	480	37

The transportation costs from each U.S. city of the three distribution centers and the demands at the distribution centers are as follows:

	Distribution Center		
Warehouse	7. Dallas	8. St. Louis	9. Chicago
4. Norfolk	$ 75	$ 63	$81
5. New York	125	110	95
6. Savannah	68	82	95
Demand	60	45	50

Determine the optimal shipments between the European ports and the warehouses and the distribution centers to minimize total transportation costs.

Value of objective function in optimal solution: 77362

Problem N

A company has a product portfolio of five products. To produce and bring the products to the market, the products require the following resources per unit:

	Product A	Product B	Product C	Product D	Product E
Manufacturing, machine hours	4 hours	3 hours	12 hours	6 hours	3 hours
Manufacturing, manpower	6 hours	10 hours	7 hours	8 hours	12 hours
Distribution, manpower	4 hours	2 hours	5 hours	5 hours	5 hours

Sales price and variable cost per unit is as follows:

	Product A	Product B	Product C	Product D	Product E
Sales price per unit	97 EUR	110 EUR	142 EUR	112 EUR	97 EUR
Variable cost per unit	58 EUR	75 EUR	72 EUR	55 EUR	40 EUR

Regarding resource availability, there are 1000 machine hours, 1100 manpower hours, and 600 distribution hours available.

a) Decide the quantity to be produced of each product, so that total marginal contribution (sales price minus variable costs) is maximized.
   Value of objective function in optimal solution: 7788.53

b) Assume that the quantities need to be integer values. What will now be the optimal solution?
   Value of objective function in optimal solution: 7780

For each product that is kept in the product portfolio, there is a fixed cost. The fixed cost will be avoided if the product is not included in the product portfolio anymore.

Fixed costs are as follows:

	Product A	Product B	Product C	Product D	Product E
Sales price per unit	400 EUR	300 EUR	700 EUR	500 EUR	600 EUR

c) Decide the quantity to be produced of each product, so that total profit (sales price minus variable costs minus fixed costs) is maximized.
   Value of objective function in optimal solution: 6464.44
   Value of objective function in optimal solution: 6463 if assuming integer quantities as in b)