SeriesNumber 36

Problem 1

A local appliance store has decided on an advertising campaign utilising newspaper and radio.
Each pound spent on newspaper advertising is expected to reach 40 people in 'Under £25,000' and 30 in the 'Over £25,000' bracket.
Each pound spent on radio advertising is expected to reach 30 people in 'Under £25,000' and 40 in the 'Over £25,000' bracket.
If the store wants to reach at least 134000 people in the 'Under £25,000' and at least 81000 in the 'Over £25,000' bracket, what is the minimum cost of the advertising campaign?

Problem 2

Peter, who currently lives in New York, wants to invest $80000. He has narrowed his choices to a municipal bond yielding 8%, an industrial bond yielding 12%, Treasury bills at 8%, and certificates of deposit (CDs) at 10%.
For safety, at least half of the funds must be placed in bonds. For liquidity, at least 26% of the funds must be invested in CDs.
Due to volatile Fed policy, no more than 28% of the portfolio can be in Treasury bills. Tax sheltering considerations dictate that at least 30% of the investment must be in municipal bonds.
What is the maximal annual interest (in $) that Peter can achieve?

Problem 3

A company must determine how much of its £240000 advertising and promotional budget should be spent in the following media: television, radio, magazines, and prize promotion.
Each pound spent on television advertising increases sales on £18; each of radio and magazine ads results in half of that return, and prize promotion returns £12 in sales for each pound invested.

Television advertising cannot exceed third of the total budget, and total radio advertising must be at least 15% of total TV advertising.
At least £27000 must be spent on magazine ads, and no more than £32000 may be spent on the prize promotion.
What is the maximal total increase in sales (in £) that can be achieved by optimal allocation of the funds in the advertisements?

Problem 4

The X Feed Company makes a feed from four ingredients - oats, corn, soybeans, and a vitamin supplement.
The company has 300 kg of oats, 200 kg of corn, 300 kg of soybeans, and 300 kg of vitamin supplement available for the mix. The company has the following recipe for the mix.

At least 30% of the mix must be soybeans
The ratio of corn to oats cannot exceed 3 to 1
At least 30% of the mix must be the vitamin supplement
The mix must be at least 965 kg

A kilogram of oat costs £0.3; a kilogram of corn, £1; a kilogram of soybeans, £0.4 and a kilogram of vitamin supplement, £1.8.
What is the minimum possible cost of the mix prepared according to the recipe above?

Problem 5

The Archer family raises cattle on their farm in West Midlands. They also have a large garden in which they grow ingredients for making two types of relish - SauceA and SauceB. These they sell at local stores.

The profit per kilogram of SauceA is £3.75 and the profit per kilogram of SauceB is £4.5. The ingredients in each relish are cabbage, tomatoes, onions, and oil. One kilogram of SauceA must contain at least 55% but no more than 71% cabbage, and at least 3% onion, and at least 7% oil. One kilogram of SauceB must contain at least 55% but no more than 75% tomatoes, and at least 7% onion, and at least 6% oil. Both relishes contain no more than 12% onion and no more than 10% oil.

The family has enough time to make no more than 810 kilograms of relish. They know also that they will sell at least 30% more SauceA than SauceB. They will have this year 270 kilograms of cabbage, 460 kilograms of tomatoes, and 100 kilograms of onion. They can use any amount of oil needed.

What is the maximal profit that the family can gain by producing and selling the relish?

Problem 6

Sunco Oil produces oil at two wells. Well 1 can produce as many as 180000 barrels per day, and well 2 can produce as many as 140000 barrels per day.

It is possible to ship oil directly from the wells to Sunco's customers in Los Angeles and New York. Alternatively, Sunco could transport oil either to the port of Mobile or Galveston and then ship it by tanker to New York or Los Angeles.

Transhipment capacities through Mobile are bounded by 42000 barrels per day; capacities in Galveston are unlimited.

Los Angeles requires 84000 barrels per day, and New York requires 97000 barrels per day. The costs of shipping 1000 barrels between two points are shown in the table below.

	To			
From	Mobile	Galveston	N.Y.	L.A.
Well 1	6	14	30	39
Well 2	26	30	27	21
Mobile			15	12
Galveston			14	10

What is the minimal transportation costs of meeting oil demands in Los Angeles and New York?

Problem 7

A company receives raw materials from three suppliers. The materials have to be further refined on one of the two production sites. The cost of transportation of raw materials from the suppliers to the sites are shown in the table below:

Suppliers	Sites	
	Site 1	Site 2
S1	£7.00	£11.00
S2	£7.00	£11.00
S3	£8.00	£7.00

Suplier S1 can supply up to 90 units of the raw material, suplier S2 can supply up to 80 units, and suplier S3 can supply up to 140 units per day.

Percentage of refined product obtained on each site and for each supplier are shown in the table below:

Suppliers	Sites	
	Site 1	Site 2
S1	90%	90%
S2	80%	60%
S3	70%	60%

The company wants to produce 100 units of refined product on site 1 and 86 units of refined product on site 2 daily.
What is the minimal transportation cost of satisfying the company's daily demand?

Problem 8

A trust officer for a bank in West Midlands wants to invest in the following bonds:

Bond	*A*	*B*	*C*	*D*	*E*
Yield	9%	9%	8%	12%	11%
Maturity	Short	Long	Long	Short	Long
Risk	Low	High	High	Low	Low
Tax-Free	No	No	Yes	Yes	Yes

She has £120000 available for the investments. To achieve a diversity in her investments she decided to satisfy the following constraints:

- At least £26000 must be placed in short maturity bonds.
- No more than £35000 may be invested in high-risk bonds.
- Total funds invested in low-risk bonds must be less than or equal to total funds placed in long-maturity bonds.

The interest income derived from tax-free bonds must be at least 15% of the total income.
What is the maximal return (in £) that the bank can achieve?

Problem 9

A local company purchases apples from local growers and makes applesauce and apple juice. It costs £0.6 to produce a kilogram of applesauce and £0.6 to produce a litre of apple juice.

The company wants to meet but not exceed the demand for each product.

The marketing manager estimates that the demand for applesauce is 5000 kilogram plus additional 4 kilograms for each £1 spent on advertising.

The demand for apple juice is estimated to be 6000 litres plus additional 2 litres for every £1 spent to promote apple juice.

The company has £12000 to spend on producing and advertising applesauce and apple juice. The company has a policy that at least 30% but no more than 55% of this budget should be used for producing apple juice.

Given that the applesauce sells for £1.25 per kilogram, apple juice sells for £1.65 per litre, what is the maximal profit that the company can achieve using the budget in optimal way?

Problem 10

Sanders Fishing Supply of Naples, Florida, manufactures a variety of fishing equipment, which it sells throughout the United States.

For the next three months, Sanders estimates demand for a particular product at 135, 120, and 110 units, respectively. Sunders can supply this demand by producing on regular time or overtime. Because of other commitments and anticipated cost increases in month 3, the production capacities in units and the production costs per unit are as follows:

Production	*Capacity*	*Cost/unit*
Month 1 - regular	105	$30.00
Month 1 - overtime	135	$45.00
Month 2 - regular	125	$55.00
Month 2 - overtime	105	$65.00
Month 3 - regular	115	$90.00
Month 3 - overtime	45	$105.00

Inventory may be carried from one month to the next, but the holding cost is $12 per unit per month.

What is the minimal cost of meeting demands in the next three months?