(**Remark** : Question 61 to 70 are not examinable in End of Semester Exam. Questions 73 to 76 are indicative of potential exam questions.)

61. Use LP software to solve the following IP problem, where x, y are integers that are ≥ 0.

```
maximize p = 5x + 7y subject to
30x + 33y <= 2100
50x + 24y <= 2400
x <=45
y <=60
```

62. Use LP software to solve the following IP problem, where x, y are integers that are ≥ 0.

```
maximize p = 3x + y subject to
5x - 6y <= 90
2x + 5y <= 190
y <= 32
X <= 38
```

63. Use LP software to solve the following IP problem, where x, y are integers that are ≥ 0.

```
maximize p = 3x + y subject to
2x - y <= 40
2x + 3y <= 64
y <= 15
x <= 22
```

64. Use LP software to solve the following IP problem, where x, y are integers that are ≥ 0.

```
maximize p = 7x + 3y subject to
2y<=63
2x + 6y <= 205
2x + 2y <= 109
4x + y <= 180
x <= 43
```

65. Use LP software to solve the following IP problem, where x, y are integers that are ≥ 0.

```
maximize p = 7x + 5y subject to
7x + 9y <=  450
6x + 11y <= 380
y <= 35
x <= 50
```

66. Use LP software to solve the following IP problem, where x, y are integers that are ≥ 0.

```
maximize p = 3x + y subject to
7x - 3y <= 70
2x + 5y <= 180
y <= 30
```

67. Use LP software to solve the following IP problem, where x, y are integers that are ≥ 0.

```
maximize p = 5x + 2y subject to
30x + 33y <= 2100
50x + 24y <= 2400
x <=45
y <=60
```

68. Use LP software to solve the following IP problem, where x, y are integers that are ≥ 0.

```
maximize p = 3x + 7y subject to
2x - y <= 40
2x + 3y <= 90
y <= 25
```

69. Use LP software to solve the following IP problem, where x, y are integers that are ≥ 0.

```
maximize p = 3x + 8y subject to
2x - y <= 40
2x + 3y <= 90
y <= 25
```

70. Use LP software to solve the following IP problem, where x, y are integers that are ≥ 0.

```
maximize p = 7x + 5y subject to
2y<=63
2x + 6y <= 205
2x + 2y <= 109
4x + y <= 180
x <= 43
```

71. OBKB Investments is considering investments into 5 projects: A, B, C, D, and E.

    Each project has an initial cost, an expected profit rate (one year from now) expressed as a percentage of the initial cost, and an associated risk of failure. These numbers are given in the table below:

	A	B	C	D	E
Initial Cost	1.5	0.9	0.7	1.5	2.1
Profit Rate	10%	15%	10%	12%	10%
Failure Risk	6%	4%	6%	5%	4%

   (a) Provide a formulation to choose the projects that maximize total expected profit, such that OBKB Investments does not invest more than 5M dollars and its average failure risk is not over 5%.

   For example, if OBKB Investments invests only into A and B, it invests only 2.5M dollars and its average failure risk is $(6\% + 4\%)/2 = 5\%$.

   (b) Suppose that if A is chosen, B must be chosen. Modify your formulation.

   (c) Suppose that if C is chosen, E must not be chosen. Modify your formulation.

   (d) Suppose that if A and C are chosen, D must be chosen. Modify your formulation.

72. ERBIZAKIP Investments is considering investments into 6 projects: A, B, C, D, E and F.

Each project has an initial cost, an expected profit rate (one year from now) expressed as a percentage of the initial cost, and an associated risk of failure. These numbers are given in the table below:

	A	B	C	D	E	F
Initial Cost	1.8	1.5	1.1	1.8	2.1	3.2
Profit Rate	11%	13%	10%	12%	11%	9%
Failure Risk	6%	4%	5.5%	5%	4.5%	4.5%

(i) Provide a formulation to choose the projects that maximize total expected profit, such that ERBIZAKIP Investments does not invest more than 5M dollars and its average failure risk is not over 5%.

You may assuming equal weighting for each project when determining average risk. For example, if ERBIZAKIP Investments invests only into A,B and C, it invests only 4.4M dollars and its average failure risk is $(6\% + 4\% + 5\%)/3 = 5\%$.

(ii) Suppose that if C is chosen, D must be chosen. Modify your formulation.

(iii) Suppose that if A and C are chosen, D must be chosen. Modify your formulation.

(iv) Suppose that only two projects, at most, can be chosed from A, B and C. Modify your formulation.

73. Use Simplex Tableaux to solve the follow maximization problem. (Assume x and y > 0).

```
maximize p = 3x + 2y subject to
2x - 1y <= 8
x + 2y <= 14
```

74. Use Simplex Tableaux to solve the follow maximization problem. (Assume x and y > 0).

```
maximize p = 3x + 2y subject to
2x - 1y <= 9
x + 2y <= 17
```

75. Use Simplex Tableaux to solve the follow maximization problem. (Assume x and y > 0).

76. Use Simplex Tableaux to solve the follow maximization problem. (Assume x and y > 0).

```
maximize p = 3x + 2y subject to
2x - 1y <= 13
x + 2y <= 19
```

77. Essay style question on the construction and interpretation of ROC curves.

    - What is the purpose of the plot?
    - What are the Axes?
    - Show how to interpret the curve using a few sketches.

78. Encoding constraints for Binary IP problems.

    - Similar to Question 72.

79. A normally distributed quality characteristic is monitored through the use of control charts. These charts have the following parameters. All charts are in control.

	LCL	Centre Line	UCL
$\bar{X}$-Chart	542	550	558
R-Chart	0	8.236	16.504

   (i.) (2 marks) What sample size is being used for this analysis?

   (ii.) (2 marks) Estimate the mean of the standard deviations $\bar{s}$ for this process.

   (iii.) (2 marks) Compute the control limits for the process standard deviation chart (i.e. the s-chart).

80. A normally distributed quality characteristic is monitored through the use of control charts. These charts have the following parameters. All charts are in control.

	LCL	Centre Line	UCL
$\bar{X}$-Chart	1995	2000	2005
R-Chart	0	21	44.394

   (i.) (2 Marks) What sample size is being used for this analysis?

   (ii.) (2 Marks) Estimate the mean of the process standard deviations $\bar{s}$.

   (iii.) (2 Marks) Compute the control limits for the process standard deviation chart (i.e. the s-chart).

81. The **Nelson Rules** are a set of eight decision rules for detecting "out-of-control" or non-random conditions on control charts. These rules are applied to a control chart on which the magnitude of some variable is plotted against time. The rules are based on the mean value and the standard deviation of the samples.

   (i) Discuss any four of these rules, and how they would be used to detect "out of control" processes. Support your answer with sketch.

In your answer, you may make reference to the following properties of the Normal Distribution. Consider the random variable X distributed as

$$X \sim \mathcal{N}(\mu, \sigma^2)$$

where μ is the mean and σ^2 is the variance of an random variable X.

- $\Pr(\mu - 1\sigma \leq X \leq \mu + 1\sigma) = 0.6827$
- $\Pr(\mu - 2\sigma \leq X \leq \mu + 2\sigma) = 0.9545$
- $\Pr(\mu - 3\sigma \leq X \leq \mu + 3\sigma) = 0.9973$

82. (5 Marks) By removing all strategies which are dominated by strict pure or mixed strategies, derive the reduced version of the following 2-player zero-sum matrix game:

	D	E	F
A	(1,1)	(6,4)	(6,9)
B	(2,6)	(0,8)	(4,7)
C	(3,5)	(1,2)	(5,3)

Derive the minimax strategies and value of the above game.