NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

TIE6134

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

TIE6134: OPERATIONS RESEARCH

June 2009

Time : 3 hours

Candidates should attempt **ALL** questions from Section A and **ANY THREE** questions from Section B.

SECTION A: Answer ALL questions in this section [40].

A1. Define the following terms as applied to network models:

(a) Network,

(b) path,

(c) directed arc,

(d) directed loop,

(e) spanning tree. [1,1,2,2,2]

A2. Groote-Schuur Engineering uses a single machine to process three jobs. Both the processing time and the due date(in days) are given in the following table:

Job	Processing time	Due date	Late penalty($/day)
1	5	25	19
2	20	22	12
3	15	35	34

The objective of the problem is to determine the minimum late-penalty sequence for the processing of the three jobs. Formulate as an integer linear programming model. [9]

A3. The sales forecast data for 2007 for Global Engineering are given in table below:

Model	Units(thousands)
Deluxe model, x_1	500
Standard model, x_2	750
Export model, x_3	400

Two production facilities are required, machining and assembly, and these are common to each model. Capacity in each facility is limited by the number of direct labour hours available(see table).

		Labour hours per unit		
Facility	Total labour hours available(millions)	x_1	x_2	x_3
Machining	1.4	0.5	0.5	1
Assembly	1.2	0.5	0.5	2.0

Profit contributions per model are given table below:

Model	Amount per 1000 units($))
Deluxe model, x_1	1 500
Standard model, x_2	1 300
Export model, x_3	2 500

Formulate as a linear programming model to determine the optimal product mix that maximises the total profit contribution. [10]

A4. (a) Outline the distinctive characteristics of the dynamic programming approach to problem solving. [5]

(b) A 4-ton vessel is loaded with one or more items. The following table gives the unit weight, w_i, in tons and the unit revenue, r_i, in thousands of dollars for each item i.

Item i	w_i	r_i
1	2	31
2	3	47
3	1	14

Using the dynamic programming approach, determine how the vessel should be loaded to maximize the total return. [8]

SECTION B: Answer THREE questions in this section [60].

B5. (a) Briefly discuss the relevance of integer linear programming in industrial operations. [4]

(b) Jobco is planning to produce at least 2 000 widgets on three machines. The minimum lot size on any machine is 500 widget. Each machine has a set-up cost and a production cost per unit. The capacity of each machine is given in table below:

Machine	Set-up cost	Production cost/unit	Capacity(units)
1	300	2	600
2	100	10	800
3	200	5	1200

The problem facing Jobco is which machine to use and in what quantities in order to meet its daily demand at a minimum total cost. Formulate as an integer linear programming model. [16]

B6. A manufacturing company produces high quality products on two production lines, the first being staffed with skilled workers who can produce four products per hour and the second with less experienced employees who can produce only two products per hour. The normal working hours for each line are 40 hours per week. The operating costs of the two production lines are basically the same. The production manager for this firm has prioritised the production objectives for the following week as follows:

P1: Production of at least 210 products weekly.
P2: Avoid the over-utilization of regular working hours for both production lines.
P3: Avoid the under-utilization of regular working hours for both production lines.

(a) Develop a goal programming model for an optimal decision. [16]

(b) The production manager wishes to weight the last two priotisized objectives differently having found that it is twice as important to avoid over-utilization of production line 2 as line 1, while for priority 3: it is three times as important to avoid under-utilization of production line 1 as line 2. Make any relevant adjustments to your model. [4]

B7. The major jobs to be completed in constructing a house, with their immediate predecessors and estimated time durations(days) are listed below:

Job	Description	Immediate predecessors	Duration
1	Clear site	-	2
2	Pour slab	1	1
3	Erect frame	2	2
4	Erect roof	3	3
5	Fasten wall panels	4	2
6	Plaster walls	5	2
7	Install window+door frames	3	2
8	Finish carpentry	6,7	6
9	Vanish panels	8	3
10	Install plumbing	9	1
11	Lay bathroom tiles	10	2
12	complete plumbing	11	1
13	Lay flooring	12	2
14	Install geyser	5	1
15	Lay brick work	4	3
16	Install roof tiles	3	2
17	Fit gutters	15,16	2
18	Paint fittings	17	2
19	Insulate attic	6,15	1
20	Construct driveway	15	1
21	Land scaping	20	1
22	Install electrical fittings	14	1
23	Test electrical circuit	22	1
24	Cleaning	13,18,19,23	1
25	Finishing	21,24	1

(a) Draw the activity network diagram for the project. [10]

(b) Calculate, using the diagram in (a), the earliest occurrence and latest occurrence times for each activity. [6]

(c) Identity the critical path and state the minimum duration of the project. [4]

B8. (a) As an operations management specialist wishing to use metaheuristics in modern quantitative decision making, explain the challenges you are likely to face in the implementation stage. [6]

(b) Use simulated annealing, genetic algorithm or any other other meta heuristic of your choice, for the following tasks:

(i) Give a brief outline of the pseudo code or algorithm for the meta heuristic chosen. [5]

(ii) Given a flow-shop sequencing and scheduling problem for 5 jobs, demonstrate with the aid of pseudo code or flow chart, how to implement the meta heuristic to optimize the sequencing problem using the make-span or tardiness objective. [5]

(iii) State any other four applications of meta heuristics, apart from flow-shop scheduling. [4]