NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF THE BUILT ENVIRONMENT

DEPARTMENT OF QUANTITY SURVEYING

PART IV EXAMINATIONS JANUARY 2011

Construction Planning Simulation and Scheduling AQS 4102:

Time 3 Hours   **TOTAL MARKS: 100**

Answer **ALL** questions in section A and any **THREE** from Section **B.** Section **A** carries 40 marks and in Section **B** each question carries 20 marks.

SECTION A

1. A cement manufacturer produces two types of cement, namely granules and powder. He cannot make more than 1600 bags a day due to a shortage of vehicles to transport the cement out of the plant. A sales contract means that he must produce at least 500 bags of powdered cement per day. He is further restricted by a shortage of time; the granulated cement requires twice as much time to make as the powdered cement. A bag of powdered cement requires 0.24 minutes to make and the plant operates an 8 hour day. His profit is $4 per bag for granulated cement and $3 per bag for the powdered cement**.**

   (i) Formulate the problem as a linear program.
   (ii) Solve this linear program graphically.   **[5+5marks]**

   2.

Activity	Preceding activities	Required time(weeks)		Cost($000s)	
		Normal	Crash	Normal	Crash
A	-	4	2	10	11
B	A	3	2	6	9
C	A	2	1	4	6
D	B	5	3	14	18
E	B,C	1	1	9	9
F	C	3	2	7	8
G	E,F	4	2	13	25

H	D,E	4	1	11	18
I	H,G	6	5	20	29

(a) What is the critical path and the estimated completion time of the project?

(b) To shorten the project by three weeks, which tasks will be shortened and what would the final total project cost be? **[5+5marks]**

3. (a) State two advantages and three disadvantages of simulation.

(b) A warehouse contains 100 bags of cement, of which 10% are of PPC type, 40% are of PMC type and 50% of the Portland type, develop a simulation model for the process of drawing bags of cement at random from the warehouse. Each time a bag of cement is drawn and its type is noted, it is replaced. Use the following random numbers as you desire.

26768	66954	83125	08021
42613	17457	55503	36458
95457	03704	47019	05752
95276	56970	84828	05752

Simulate drawing 10 bags of cement from the warehouse. Show clearly the random numbers you have used.

[5+5marks]

4. Consider the transportation problem with the following cost parameter table:

	Destination					
	A	B	C	D	E	Supply
1	16	16	13	22	17	50
2	14	14	13	19	15	60
3	19	19	20	23	M	50
4D	M	0	M	0	0	50
Demand	30	20	70	30	60	

Calculate the values of the objective function using:
  (a) Northwest corner method
  (b) Vogel's approximation method. **[5+5marks]**

5. A contractor, Mr Mwemba, is to haul gravel from three sites to two building sites (plants). The three sources of gravel willing to supply gravel in the following amounts:

   - S1: 200 tonnes at $11/tonne
   - S2: 310 tonnes at $10/tonne
   - S3: 420 tonnes at $9/tonne

Haulage costs in $ per tonne are:

To:	Plant A	Plant B
From: S1	3	3.5
S2	2	2.5
S3	6	4

Plant capacities and labour costs are:

	Plant A	Plant B
Capacity	460 tonnes	560 tonnes
Labour cost	$26/tonne	$21/tonne

The gravel is sold at $50/tonne to the distributors. The company can sell at this price all they can produce.

The objective is to find the best mixture of the quantities supplied by the three sources to the two plants so that the company maximises its profits.

   (a) Formulate the problem as a linear program and explain it
   (b) Explain the meaning of the dual values associated with the supply and plant capacity constraints
   (c) What assumptions have you made in expressing the problem as a linear program.

   [10+5+5marks]

6. The manager of a construction company needs to assign builders to complete a project that they have just started. Since most of his best builders are very fast when using different size of bricks, it is not clear which builder should be assigned to each of the four different bricks that are available. The five fastest builders and the best time(in minutes) that they have achieved in previous projects are recorded in table below:

|		Builder				
		Sam	Tom	Lee	Joe	Ben
	20-inch	370	320	330	370	350
	15-inch	430	330	420	340	410
Bricks	10-inch	330	280	380	300	330
	5-inch	290	260	290	280	310

The manager wishes to determine how to assign four builders to the four different bricks size to minimise the sum of the corresponding best builders.
(a) Formulate this problem as an assignment problem.
(b) Obtain an optimal solution using the Hungarian method.
(c) Assume that Joe for some reason can no longer use the 5-inch brick, obtain the new assignment under this new development.   **[10+5+5marks]**

7. Copac has held public hearings concerning the development of a new constitution for our country Zimbabwe. As a result of these hearings, Copac has decided to build a system linking eight residential and commercial centers at minimum cost.

Copac engineers have drafted a series of feasible lines and this is illustrated below:
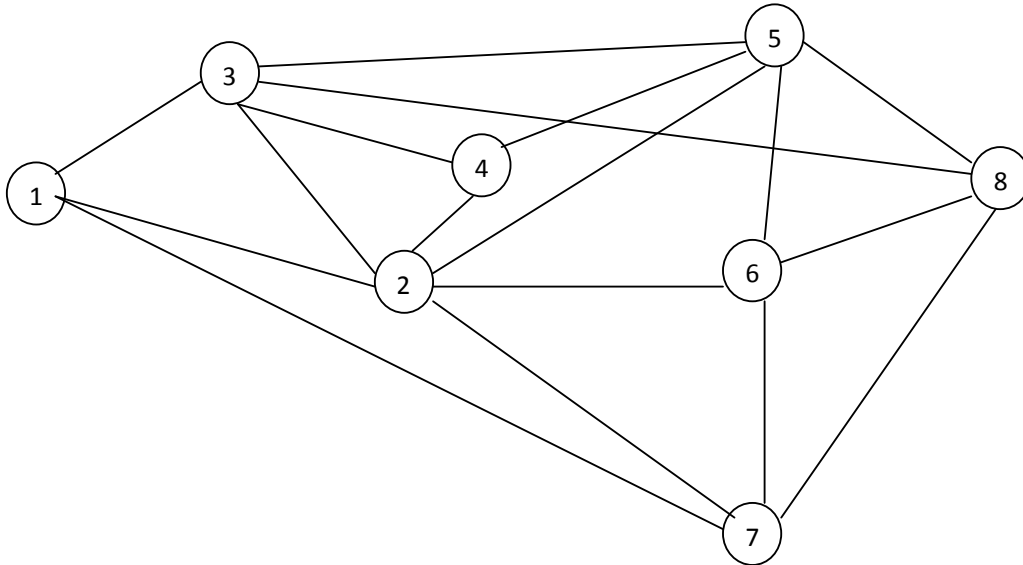
Distance between a pair of locations [i-$j \rightarrow a$: means distance from center i to center j is a].

1-2 ⟶ 28	2-6 ⟶ 41	5-6 ⟶ 45
1-3 ⟶ 33	2-7 ⟶ 37	5-8 ⟶ 38
1-7 ⟶ 40	3-4 ⟶ 30	6-7 ⟶ 36
2-3 ⟶ 34	3-5 ⟶ 50	6-8 ⟶ 43
2-4 ⟶ 32	3-8 ⟶ 55	7-8 ⟶ 44
2-5 ⟶ 35	4-5 ⟶ 39	

Copac has solicited sealed bids from contractors interested in building some or all of the system and determine the lowest feasible bid for each possible link. These costs may be further reduced on certain routes due to private funding pledged by donors and business people or some other companies.

Advice Copac on routes to take in order to minimise the total cost to donors and other organisations funding the project, while still providing a way to travel from any one of the centers to any of the other seven centers served by the system.   **[20marks]**

8. A Company dealing with quantity surveying commodities franchise combination gas and car wash stations throughout Zimbabwe. The company gives a free car wash for a gasoline fill-up or, for a wash alone, charges $0.50. Past experience shows that the number of

customers that have car washes following fill-ups is about the same as for a wash alone. The average profit on gasoline fill-up is about $0.70 and the cost of the car wash to automatic machine is $0.10. Automatic machine stays open 14 hours per day.

Automatic machine has three power units and drive assemblies, and a franchisee must select the unit preferred. Unit I can wash cars at the rate of one every five minutes and is leased for $12 per day. Unit II, a larger unit, can wash cars at the rate of one every four minutes but costs $16 per day. Unit III, the largest, costs $22 per day and can wash cars at the rate one every three minutes.

The franchisee estimates that customers will not wait in line for more than five minutes for a car wash. A longer time will cause automatic machine to lose the gasoline sales as well as the car wash sale. If the estimate of customer arrivals resulting in washes is 10 per hour:

(a) Which unit must the company purchase and why?

(b) Suppose the arrival rate increases, what effect will it have on your decision in (a).

[10+10 marks]

END OF EXAMINATION