NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

B-Eng Hons Industrial and Manufacturing Engineering

Main Examination

COURSE : MANUFACTURING SYSTEMS I

CODE : TIE 3112

DATE : JANUARY 2013

DURATION : 3 HOURS

INSTRUCTIONS AND INFORMATION TO CANDIDATE

1. Answer ANY five questions.
2. All questions carry **20 marks** each.
3. This paper contains seven **(7)** questions.
4. There are four **(4)** printed pages.

QUESTION 1

Five departments are to be assigned to locations B-F in the grid shown in Figure Q1. For technical reasons, department 6 must be assigned to location A. Transportation cost is $2 per metre. The objective is to minimise total transportation cost. Table Q1a and Table Q2b show information interdepartmental work flows and distances between locations respectively.

Assign the departments so that total transportation cost is minimised. [20]

A	**B**	**C**
D	**E**	**F**

Figure Q1: Location grid

Table Q1a: Number of trips per day between Departments

FROM/TO	**1**	**2**	**3**	**4**	**5**	**6**
1	-	125	62	64	25	50
2		-	10	17	26	54
3			-	2	0	20
4				-	13	2
5					-	5
6						-

Table Q1b: Distance between Locations (metres)

FROM/TO	**A**	**B**	**C**	**D**	**E**	**F**
A	-	50	100	50	80	130
B		-	50	90	40	70
C			-	140	60	50
D				-	50	120
E					-	50
F						-

QUESTION 2

a) Outline five objectives of layout design. [5]
b) Using an appropriate diagram, compare the five generic types of manufacturing processes in terms of production volumes and product variety. [15]

QUESTION 3

A 20 stage transfer line with two buffers is being considered. Tentative plans place buffers of size 15 after workstations 10 and 15. The first 10 workstations have a cumulative failure rate of $\alpha = 0.005$. Workstations 11 to 15 have a cumulative failure rate of $\alpha = 0.01$ and workstation 16 to 20 together yield a failure rate of $\alpha = 0.005$. Repair of any station would average 10 cycles in length. Estimate the effectiveness of this line design. [20]

QUESTION 4

a) Outline the steps involved in systematic layout planning (SLP). [10]
b) A company wishes to establish the best location for a new production facility that will supply five warehouses in different locations. The locations and the demand for each of the warehouses are shown in Table Q4. The unit transportation cost per unit distance is assumed to be the same for the four warehouses. Use the Centre of Gravity method to determine the best location for the new production facility. [10]

Table Q4: Warehouse Locations and Demand

Warehouse	Location (x, y)	Demand (units)
A	(200,300)	5000
B	(100,50)	1500
C	(50,200)	3000
D	(50,50)	200
E	(75, 150)	400

QUESTION 5

a) Briefly explain any four methods that can be used to improve line balance. [8]
b) Transfer line systems are characterised by operation dependant and time dependant failures. Distinguish the two failure types. [4]
c) Consider a four station line. Given that station one and three fails on average every 10 cycles, the station two every 15 cycles, station four every 20 cycles, and the average repair time is 3 cycles, determine the line effectiveness assuming the following:
    i) The line is subjected to operation dependant failures [4]
    ii) The line is subjected to time dependant failures [4]

QUESTION 6

a) Give brief explanations of the following three methods of work transportation:
   i) Synchronous transfer [2]
   ii) Asynchronous transfer [2]
   iii) Continuous transfer [2]

b) Outline the factors you would consider when selecting the most appropriate method of work part transportation. [4]

c) Suppose a 5 station transfer line is being considered for production of a particular product. The weekly demand is 500 units and the production department has estimated that the ideal cycle time T_c is 20 minutes. It is also estimated that breakdown of all types will occur with a frequency F = 0.2 breakdowns per cycle and that the average downtime per line stop will be 30 minutes (T_d = 30 mins). The scrap rate for the current processing method is 2.5% and this is considered a good estimate for the transfer times. Material costs are $150 per unit and it will cost $300 an hour ($5 per minute) to operate the transfer line. Tooling costs are estimated to cost $5 per unit. Determine the following:
   i) Production rate [4]
   ii) Line efficiency [2]
   iii) Cost per unit produced [2]
   iv) Hours required to meet weekly demand [2]

QUESTION 7

a) Explain what is meant by line balancing and outline its importance. [4]
b) An assembly line consists of twelve work elements as shown in Table Q7. Assuming a cycle time of 1 minute, you are required to design a well balanced assembly line.

Table Q7: Element Description and Data for Question 7

Element	1	2	3	4	5	6	7	8	9	10	11	12
Processing time T_{ej} (min)	0.2	0.4	0.7	0.1	0.3	0.11	0.32	0.6	0.27	0.38	0.5	0.12
Preceded by	-	-	1	1,2	2	3	3	3,4	6,7, 8	5,8	9,10	11

i) Determine the minimum possible number of workstations for the line. [2]
ii) Use the Largest Candidate Rule method to balance the assembly line. [14]

END OF EXAMINATION