NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

1st SEMESTER EXAMINATION - FEBRUARY 2010

MANUFACTURING SYSTEMS I - TIE 3112

Time Allowed: 3 Hours

INSTRUCTIONS TO CANDIDATES

1. **Answer Any Five (5) Questions**
2. **All Questions Carry Equal Marks**

QUESTION 1

(a) Give a detailed analysis of any three (3) generic manufacturing processes, with emphasis on the following:

(i) Operational characteristics [3]

(ii) Business Implications [3]

(iii) Applicability and examples in Zimbabwean companies on the stock exchange market if any [3]

(b) Transfer line systems are characterised by operation – dependant and time-dependant failures.

(i) Distinguish the two failure types [3]

(ii) Consider a 2- station transfer line. Given that station one fails on average every 10 cycles, the second every 15 cycles and average repair time is two cycles, determine line availability [5]

(c) State and give the fundamental characteristics of any 3 batch related hybrid processes. [3]

QUESTION 2

a) In manufacturing facility location problems, there are two known basic types of distance measures. Formulate how these two different distance measures are implemented in locating a facility X at a point (x,y) in relation to other existing facilities P_i at distinct points (a_i,b_i). [2]

b) Six sources of raw materials necessary for a given product are located at six different geographical locations. Two towns are being considered as possible locations for the processing plant, Town A (40, 40) and town B (70, 50). Raw material sources coordinates are given in the Table Q2 below.

Given that: loading costs L_k = $7
Unloading costs L_{ku} = $3
Transport cost per unit distance C_k = $0.01/m

You are required to determine the best location for the processing plant. [10]

Table Q2

Customer	Coordinates	No of trips	Route type
1	(30,60)	185	Rectilinear
2	(50,20)	250	Rectilinear
3	(55,45)	160	Rectilinear
4	(80,55)	210	Straight line
5	(30,30)	200	Straight Line
6	(20,10)	180	Straight Line

(c) An Industrial Engineer has identified a bottleneck station in a production line. A surge in product demand has necessitated a reduction in workstation cycle time. Give and explain in detail any four (4) approaches to achieve this objective. [8]

QUESTION 3

(a) Using the flow data in Table 2 and assuming a given starting solution for a facility layout in Figure 1, use the *Pair-wise switch* method to refine the current given solution. Assume that all departments have equal size and will be constructed as squares in a 1 x 4 grid with distances between them. [12]

3	**2**	**1**	**4**

Figure 2: Starting solution

Table 2: Flow Data

From \ To	**1**	**2**	**3**	**4**
1	**-**	**15**	**20**	**30**
2		**-**	**15**	**10**
3			**-**	**5**
4				**-**

(b) Group technology gains for batch processes, some of the advantages from the high volume line situations. Outline the advantages gained in layout redesign from a job shop to U-shaped cell layout. [8]

QUESTION 4

An assembly line constitutes twelve (12) work elements as reflected in Table Q4 below. Assuming cycle time of 0.9 min, you are required to design a well balanced assembly Line, by;

Table Q4

	Work element	T_{ej} (min)	Predecessors
1	Locate base	0.19	-
2	Fit plug	0.36	-
3	Install bracket	0.70	1
4	Connect motor	0.09	1,2
5	Connect timer	0.3	2
6	Fit plate	0.11	3
7	Fit motor	0.32	3
8	Fit blade	0.65	3,4
9	Align motor	0.25	6,7,8
10	Fit timer to bracket	0.39	5,8
11	Fit cover	0.5	9,10
12	package	011	11

i) Identify the minimum possible number of workstations for the line [2]

ii) Use the largest Candidate Rule method to balance the assembly line [11]

iii) Determine the effectiveness of the assembly line design [3]

iv) Locate the bottleneck on the assembly line designed. How can the effect be minimized? [4]

QUESTION 5

(a) A 10-station transfer line is to be considered for production of a component (currently produced by conventional means) to be used on an electric motor. The demand per week is 1500 units, to be produced in a 5-day working week, with 8 normal hours per day The estimated cycle time T_c is 1 minute, and all breakdowns are expected to occur with frequency $F = 0.10$ breakdowns per cycle. The average downtime per line stop will be T_d =6.0 minutes, and the scrap rate is estimated at 5%. If line operational costs are expected to be $60.00 per hour, material costs $1.50 each, and cutting tools estimated at $0.15 per work-part, present quantitative analysis of;

i) expected production rate

ii) line efficiency

iii) total cost per unit produced

iv) number of hours required to meet the demand

v) overtime required, if any [14]

(b) Outline the steps involved in systematic layout planning (SLP) [6]

QUESTION 6

(a) The costs of setting up a given multi-model assembly line (see Table Q6) comprises the cost of tool and machine change-over, tool and machine resetting, machine and labor idle time, as well as the nature of the preceding and succeeding models. Apply the Hungarian method to find the order of the model batches to minimize the total set-up costs. [10]

Table 6.1 Cost of setting up line ($000)

	Succeeding model			
	A	**B**	**C**	**D**
A	-	100	150	80
B	50	-	100	75
C	80	40	-	110
D	115	100	60	-

(b) In the context of work-part transportation, distinguish between synchronous and asynchronous transfer [5]

(c) Two approaches available

i) The upper Bound Approach and

ii) The lower Bound Approach

Estimate the frequency of line stops per cycle of transfer lines, with the aid of formulae compare and contrast these two approaches. [5]

QUESTION 7

(a) A warehouse comprises five (5) departments (see Figure 6). The approximate space requirements together with the activity relationships (A to X) and the reasons code (1 to 4) are as shown in Figure 6 and table 6.2 respectively. Carry out the facility layout design on a 100 x 150 m building whilst maintaining a 10m aisle between the departments. [10]

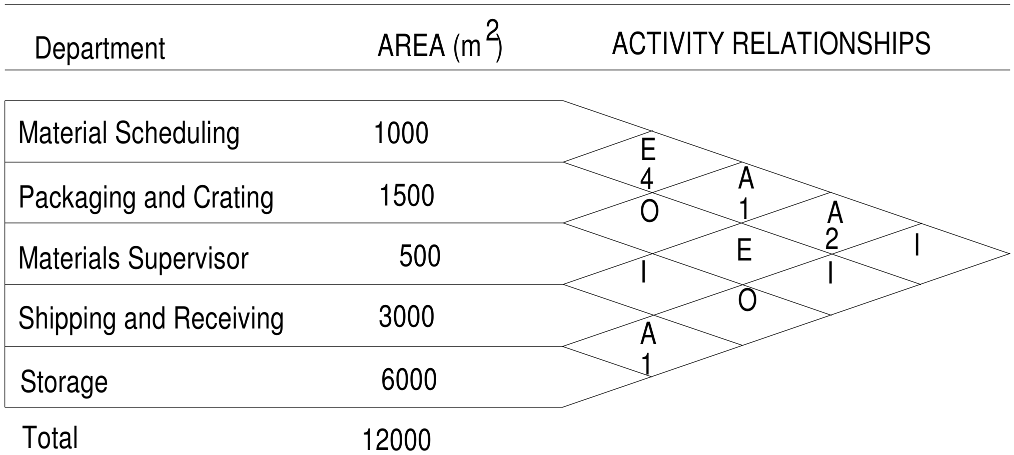

Figure 6: REL-chart

Table 6.2: Reasons codes

Code	Reasons
1	Work flow
2	Supervision
3	Safety
4	Communication

(b) Give brief explanations of the following three methods of work transportation:

i) Continuous transfer, [2]

ii) synchronous transfer, [2]

iii) asynchronous transfer [2]

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

END OF EXAM