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CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION

JANUARY 2014 SESSION

SUBJECT CODE	:	**FIB 36504**
SUBJECT TITLE	:	**COMPUTER INTEGRATED MANUFACTURING**
LEVEL	:	**BACHELOR**
TIME / DURATION	:	**3 HOURS**
DATE	:	

INSTRUCTIONS TO CANDIDATES

1. **Please read the instructions given in the question paper CAREFULLY.**
2. **This question paper is printed on both sides of the paper.**
3. **Please write your answers on the answer booklet provided.**
4. **Answer should be written in blue or black ink except for sketching, graphic and illustration.**
5. **This question paper consists of TWO (2) sections. Section A and B. Answer ALL questions in Section A. For Section B, answer THREE (3) questions only.**
6. **Answer all questions in English.**

THERE ARE 11 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

SECTION A (Total: 40 marks)

INSTRUCTION: Answer ALL questions.

Please use the answer booklet provided.

Question 1-Multiple choice, choose one correct answer

a. What is the objective of the Toyota Production System and Lean Manufacturing?

i. To reduce cost.
ii. To improve profit.
iii. To eliminate everything that does not add value for the customer.
iv. To optimize capital investment

(2 marks)

b. Making something earlier or faster than required by the next process “just-in-case” is an example of which type of waste?

i. Defect
ii. Motion
iii. Over production
iv. Over processing

(2 marks)

c. How many steps are there in 5S implementation?

i. Ten
ii. Four
iii. Five
iv. Two

(2 marks)

d. Red tags are first used in what step of 5S?

i. Set in Order
ii. Sort
iii. Standardize
iv. Sustain

(2 marks)

e. 5S is designed to do what?

i. Organize
ii. Increase efficiency
iii. Create a safe workplace
iv. All of these answers

(2 marks)

f. During Sort, you and your coworkers focus on what?

i. Ensuring 5S continues to function
ii. Establishing assigned cleaning duties
iii. Developing uniformity in facility visual communication
iv. Eliminating needless tools and equipment from the workplace

(2 marks)

g. During Set in Order, you and your coworkers focus on what?

i. Begin finding a storage place for all tools and equipment
ii. Initiate visual communication color standards
iii. Commence work area cleaning
iv. Start eliminating needless tools

(2 marks)

h. During Shine, you and your coworkers focus on what?

i. Start following scheduled work area cleanings
ii. Begin documenting visual communication needs
iii. Establish a red tag zones
iv. Initiate "shadow labeling" for tool storage

(2 marks)

i. During Sustain, you and your coworkers focus on what?

i. Photographing work areas for the first time
ii. Begin documentation of work area task times
iii. Ensuring all previous steps become facility-wide standards
iv. Start researching more efficient locations for storage

(2 marks)

j. Calculate the Takt Time based on the following information:

Customer demand is 34 400 parts per month. The company works 5 days per week and on average 20 days per month. There are two, eight hour shifts. Lunch is 30 minutes per shift. Two, ten minutes breaks are taken per shift. The calculated Takt Time is:

i. 0.5 minutes per part or 30 sec. per part.
ii. 1 parts per minute or 1 part every 60 sec.
iii. 0.5 parts per minute.
iv. 1 minute per part.

(2 marks)

Question 2

Answer the following questions based upon the following conditions.

Product:

- Part name: 10 inch pinion gear (semi-finish)
- Part number: PG6654

Process sequence:

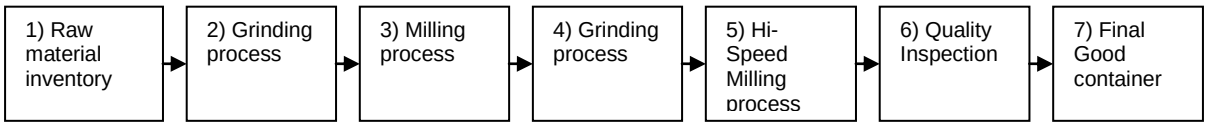

Table 1: Process sequences and details

Process Sequence	Process name	Machine number	Manual Time (sec)	Auto time (sec)	No. pieces / change	Time for tool change (sec)
1	Pick up raw material	-	1	-	-	-
2	Grinding process	GC-614	5	28	300	120
3	Milling process	CH-228	6	20	300	180
4	Grinding process	GC-1444	6	38	250	250
5	Hi Speed Milling process	CH-562	7	30	1200	600
6	Quality Inspection	-	7	-	-	
7	Place in final good container	-	2	-	-	

Manufacturing data:

- Working time is 8hrs per shift and two shifts.
- Production volume is 1200 units per day.
- Walk time between stations is 2 seconds.

a) Calculate process capacity for each machine by filling the Table 2 below. You are obliged to copy Table 2 below onto your answer booklet.

(4 marks)

Table 2: Process capacity

Step no.	Process name	Total cycle time	Tool change time per piece	Shift capacity
1	Grinding process			
2	Milling process			
3	Grinding process			
4	Hi Speed Milling process			

b) Based upon your answer for Question 2 (a), is it possible to increase the production volume to 1500 units per day? If not, what is the maximum production volume can be attained?

(4 marks)

c) Construct the standardized work combination table using the template as shown in Table 3 below and answer the following questions. You are suggested to copy Table 3 onto your answer booklet.

i. Determine the total 10 inch pinion gear's process cycle time.

(4 marks)

ii. Determine the manufacturing line takt time.

(2 marks)

iii. Is it possible to synchronize the process cycle time with the takt time?

(2 marks)

Table 3: Standardized work combination table

Line takt:		Legend:	Manual time (MT)	Walk time (WaT)
			Auto time (AT)	Wait time (WtT)

Step no.	MT	AT	WtT	WaT	Time Graph (sec)
1					
2					
3					
4					
5					
6					
7					

d) Construct the standardized work chart based on your answer for Question 2 (c) using template as Table 4 and also determine the amount of required standard in-process (SWIP) stock to ensure smooth operations. You are advised to copy Table 4 onto your answer booklet.

(4 marks)

Table 4: Standardized Work Chart

Takt time:					Production volume:		No of shift:	
Cycle time:					◯ Work Sequence —— Walking - - - - - Return to start	Safety	SWIP	Quality
Step no.	MT	AT	WtT	WaT		✚	◍	OC
1								
2								
3								
4								
5								
6								
7								

SECTION B (Total: 60 marks)

INSTRUCTION: Answer THREE (3) questions only.

Question 3

i. Table 5 lists the weekly quantities and routings of ten parts that are being considered for cellular manufacturing in a machine shop. Parts are identified by letters and machines are identified numerically.

Table 5: The weekly quantities and routings

Part	Weekly quantity	Machine routing	Part	Weekly quantity	Machine routing
A	50	$3 \rightarrow 2 \rightarrow 7$	F	60	$5 \rightarrow 1$
B	20	$6 \rightarrow 1$	G	5	$3 \rightarrow 2 \rightarrow 4$
C	75	$6 \rightarrow 5$	H	100	$3 \rightarrow 2 \rightarrow 4 \rightarrow 7$
D	10	$6 \rightarrow 5 \rightarrow 1$	I	40	$2 \rightarrow 4 \rightarrow 7$
E	12	$3 \rightarrow 2 \rightarrow 7 \rightarrow 4$	J	15	$5 \rightarrow 6 \rightarrow 1$

Determine:

a) Develop the part-machine incidence matrix.

(4 marks)

b) Apply the rank order clustering technique to the part-machine incidence matrix to identify logical part families and machine groups.

(5 marks)

ii. Five machines will constitute a GT cell. The from-to data for the machines are shown in the Table 6 below.

a) Determine the most logical sequence of machines for this data, and construct the network diagram, showing where and how many parts enter and exit the system.

(4 marks)

b) Compute the percentages of in-sequence moves, bypassing moves, and backtracking moves in the solution.

(5 marks)

c) Develop a feasible layout plan for the cell based on the solution.

(2 marks)

Table 6: Machine Cell route

From:	To:				
	1	2	3	4	5
1	0	10	80	0	0
2	0	0	0	85	0
3	0	0	0	0	0
4	70	0	20	0	0
5	20	75	0	20	0

Question 4

Table 7 below is a FMS consists of three stations plus a load/unload station. Station 1 loads and unloads parts using two servers (material handling workers). Station 2 performs horizontal milling operations with two servers (identical CNC horizontal milling machines). Station 3 performs vertical milling operations with three servers (identical CNC vertical milling machines). Station 4 performs drilling operations with two servers (identical drill presses). The machines are connected by a part handling system that has two work carriers and a mean transport time = 3.5 min. The FMS produces four parts, A, B, C, and D, whose part mix fractions and process routings are presented in the table below. The operation frequency fijk = 1.0 for all operations except operation V.Mill, fijk = 0.5.

Table 7: Operation detail of FMS

Part *j*	Part mix p_j	Operation *k*	Description	Station *i*	Process time t_{ijk}
A	0.2	1	Load	1	4 min
		2	H. Mill	2	15 min
		3	V Mill	3	14 min
		4	Drill	4	13 min
		5	Unload	1	3 min

B	0.2	1	Load	1	4 min
		2	Drill	4	12 min
		3	H. Mill	2	16 min
		4	V. Mill	3	11 min
		5	Drill	4	17 min
		6	Unload	1	3 min
C	0.35	1	Load	1	4 min
		2	H. Mill	2	10 min
		3	Drill	4	9 min
		4	Unload	1	3 min
D	0.25	1	Load	1	4 min
		2	V. Mill	3	18 min
		3	Drill	4	8 min
		4	Unload	1	3 min

Determine :

a) Use the extended bottleneck model with the following number of parts in the system: (i) N = 6 parts, (ii) N = 8 parts, and (iii) N = 10 parts.

(10 marks)

b) The manufacturing lead time for the three cases of N in (i), (ii), and (iii).

(10 marks)

Question 5

An automated assembly machine has four workstations show at Table 8. The first station presents the base part, and the other three stations add parts to the base. The ideal cycle time for the machine is 3 sec, and the average downtime when a jam results from a defective part is 1.5 min. The fraction defective rates (*q*) and probabilities that a defective part will jam the station (*m*) are given in the table below. Quantities of 100,000 for each of the bases, brackets, pins, and retainers are used to stock the assembly line for operation.

Table 8: Automated assembly machine

	Part identification	*q*	*m*
1	Base	0.01	1.0
2	Bracket	0.02	1.0
3	Pin	0.03	1.0
4	Retainer	0.04	0.5

Determine:

(a) Proportion of good product to total product coming off the line.

(6 marks)

(b) Production rate of good product coming off the line.

(4 marks)

(c) Total number of final assemblies produced, given the starting component quantities. Of the total, how many are good product, and how many are products that contain at least one defective component?

(6 marks)

(d) The number of defective assemblies determined in above part (c), how many will have defective base parts? How many will have defective brackets? How many will have defective pins? How many will have defective retainers?

(4 marks)

Question 6

A flexible manufacturing system is used to produce three products. The FMS consists of a load/unload station, two automated processing stations, an inspection station, and an automated conveyor system with an individual cart for each product. The conveyor carts remain with the parts during their time in the system, and therefore the mean transport time includes not only the move time, but also the average total processing time per part. The number of servers at each station is given in the following Table 9.

Table 9: Number of servers at each station

Station 1	Load and unload	2 workers
Station 2	Process X	3 servers
Station 3	Process Y	4 servers
Station 4	Inspection	1 server
Transport system	Conveyor	8 carriers

All parts follow either of two routings, which are $1 \rightarrow 2 \rightarrow 3 \rightarrow 4 \rightarrow 1$ or $1 \rightarrow 2 \rightarrow 3 \rightarrow 1$, the difference being that inspections at station 4 are performed on only one part in four for each product (f_{4jk} = 0.25). The product mix and process times for the parts are presented in the Table 10.

The move time between stations is 4 min.

Determine:

(a) Using the bottleneck model, show that the conveyor system is the bottleneck in the present FMS configuration, and determine the overall production rate of the system.

(6 marks)

(b) Determine how many carts are required to eliminate the conveyor system as the bottleneck.

(6 marks)

(c) With the number of carts determined in (b), use the extended bottleneck model to determine the production rate for the case when N = 8; that is, only eight parts are allowed in the system even though the conveyor system has a sufficient number of carriers to handle more than eight.

(8 marks)

Table 10: Product mix and process time

Product j	Part mix p_j	Station 1	Station 2	Station 3	Station 4	Station 1
A	0.2	5 min	15 min	25 min	20 min	4 min
B	0.3	5 min	10 min	30 min	20 min	4 min
C	0.5	5 min	20 min	10 min	20 min	4 min

Question 7

Table 11 show A robotic assembly cell uses an industrial robot to perform a series of assembly operations. The base part and parts 2 and 3 are delivered by vibratory bowl feeders that use selectors to insure that only properly oriented parts are delivered to the robot for assembly. The robot cell performs the elements in the table below (also given are feeder rates, selector proportion θ, element times, fraction defect rate q, and probability of jam m, and, for the last element, the frequency of downtime incidents p). In addition to the times given in the table, the time required to unload the completed subassembly takes 4 sec. When a line stop occurs, it takes an average of 1.8 min to make repairs and restart the cell.

Determine:

a) Yield of good product.

(6 mark)

b) Average production rate of good product

(8 mark)

c) Uptime efficiency for the cell?

(6 mark)

Hint: State any assumptions you must make about the operation of the cell in order to solve the problem.

Table 11: A Robotic assembly cell

Element	Feed rate f	Selector θ	Element	Time T_e	q	m	p
1	15 pc/min	0.30	Load base part	4 sec	0.01	0.6	
2	12 pc/min	0.25	Add part 2	3 sec	0.02	0.3	
3	25 pc/min	0.10	Add part 3	4 sec	0.03	0.8	
4			Fasten	3 sec			0.02

END OF QUESTION