Roll No.												

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST 1

Sem & AY: Odd Sem 2019-20 — **Date**: 30.09.2019

Course Code: MEC 310 — **Time**: 9.30AM to 10.30AM

Course Name: FLEXIBLE MANUFACTURING SYSTEMS — **Max Marks**: 40

Program & Sem: B.Tech.(MEC) & VII DE — **Weightage**: 20%

Instructions:

(i) Answer all questions from Part A & B.
(ii) Answer all questions sequentially.
(iii) Legible presentation & Figures to the right indicate full marks.

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries one mark. (5Qx1M=5M)

1. Which device is mostly associated with automation?
   (a). Flexible manufacturing
   (b). Robots
   (c). Computer Graphics Workstation
   (d). NC Machine (C.O.NO.1) [Knowledge]
2. Choose the basic element for an automated machine tool.
   (a). Logic
   (b). NC Tape Programming
   (c). Software,
   (d). Workstation (C.O.NO.1) [Knowledge]
3. Match the following.
   NC code Definition
   P. M05 1. Absolute coordinate system
   Q. G01 2. Dwell
   R. G04 3. Spindle stop
   S. G09 4. Linear interpolation
   (a). P-2, Q-3, R-4, S-1
   (b). P-3, Q-4, R-1, S-2
   (c). P-3, Q-4, R-2, S-1
   (d). P-4, Q-3, R-2, S-1 (C.O.NO.1) [Knowledge]

4. Name the FMS Layout Configuration given in figure 1. (C.O.NO.2) [Application]

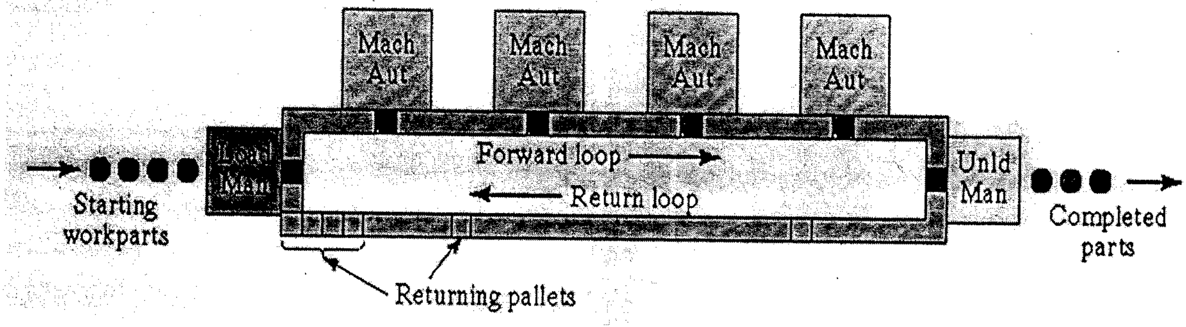


Figure 1

5. You are assigned a Group Technology Engineer in Ashok Leyland Company. How do you identify the parts Family? (C.O.NO.2) [Application]

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries five marks. (4Qx5M=20M)

6. Justify the need of FMS in Today's Competitive Environment. (C.O.NO.1) [Comprehension]
7. Do you think Adaptive Control System can be applied successfully for all machining operations? Justify your answer. (C.O.NO.1) [Comprehension]
8. Compare and Contrast: Flexible Manufacturing System with Flexible Manufacturing Cell. (C.O.NO.2) [Comprehension]
9. Formulate an APT Statement for the following diagram given in figure 2. (C.O.NO.1) [Application]

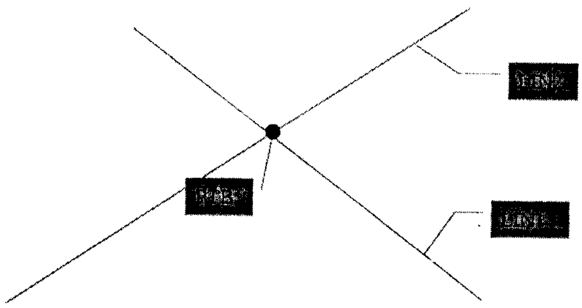


Figure 2

Part C [Problem Solving Questions]

Answer both the Questions. Each Question carries seven and half marks. (2Qx7.5M=15M)

10. Prepare a general layout of FMS and explain each component separately (C.O.NO.1) [Comprehension]

11. To prepare a CNC part program to mill the component as per the drawing figure 3 & 4. (C.O.NO.1) [Application]

Make use of G Code and M Code table given.

Assume thickness = 20mm

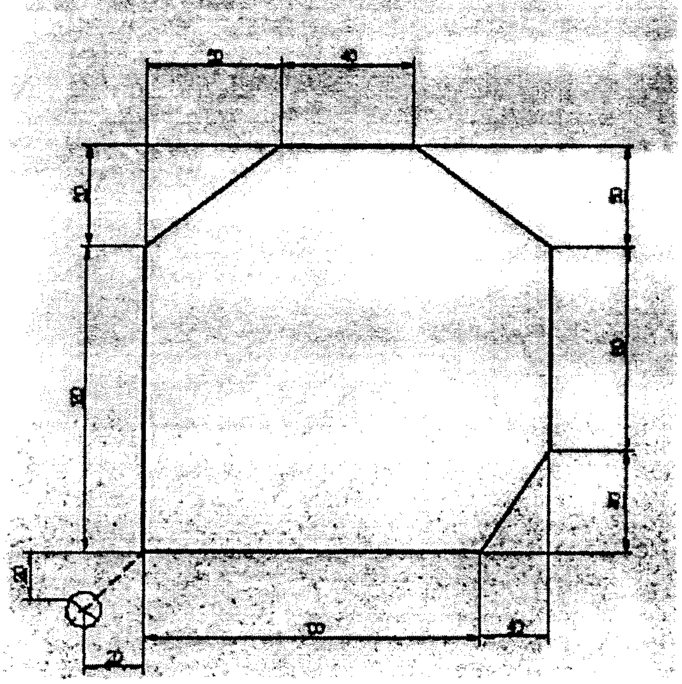


Figure 3

SIMULATION MODEL:-

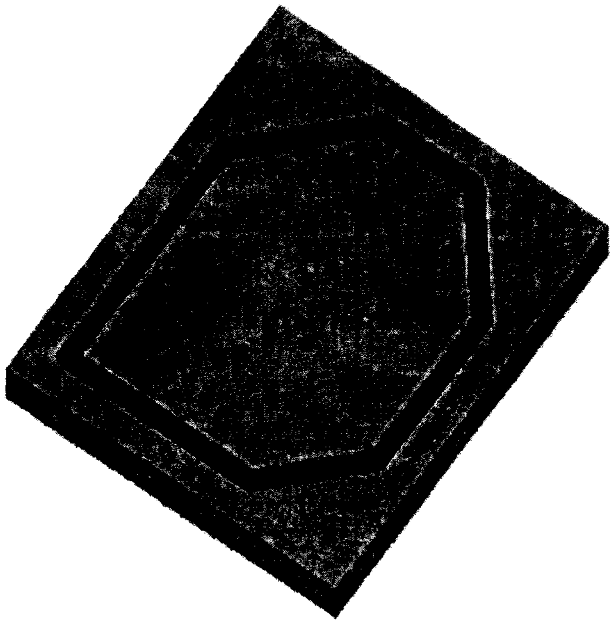


Figure 4

G CODES		M CODES	
G00	Rapid Transverse	M00	Program stop
G01	Linear Interpolation	M02	Program End
G02	Circular Interpolation, CW	M03	Spindle on Clockwise
G03	Circular Interpolation, CCW	M04	Spindle on Counterclockwise
G17	XY Plane Selection	M05	Spindle Stop
G20/G70	Inch units	M06	Tool Change
G21/G71	Metric Units	M08	Coolant on
G54	Use fixture offset 1	M09	Coolant off
G90	Absolute positioning	M10	Clamps on
G91	Incremental positioning	M11	Clamps off
G95	Feed Per Revolution	M30	Program Stop, Rest to start

SCHOOL OF ENGINEERING

Semester: Seven VII

Course Code: MEC 310

Course Name:FMS

Date: 30/09/2019

Time: 9.30-10.30

Max Marks: 40

Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO	CO.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels			Thought provoking type [Marks allotted] Bloom's Levels			Problem Solving type [Marks allotted]			Total Marks
			K			C			A			
1	1	1	L		1							1
2	1	1	L		1							1
3	1	1		M	1							1
4	2	2			1					M		1
5	2	2			1				L			1
6	1	1					M	5				5
7	1	1					M	5				5
8	2	2					M	5				5
9	1	1						5				5
10	1	1				L		7.5				7.5
11	2	2					M	7.5				7.5
12	1	1						7.5			H	7.5
	Total Marks		2	1		7.5	22.5	5	1	1	7.5	40

K =Knowledge Level   C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

[I hereby certify that All the questions are set as per the above guide lines. Dr. S Ramesh]

Reviewers' Comments

SCHOOL OF ENGINEERING

SOLUTION

Semester:

Course Code:

Course Name:

Date:

Time:

Max Marks:

Weightage:

Part A (Q x M = Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	B	One Mark for correct answer	1 min
2	A	One Mark for correct answer	1 min
3	C	One Mark for correct answer	1 min
4	FMS Rectangular Layout	One mark	2 min
5	1 Visual Inspection 2 Parts classification and coding 3 Production flow analysis	Each answer carries – 0.4 Marks All 3 Correct – 1 Mark	2 min

Part B (Q x M = Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
6	Discussion and comprehension about FMS evaluation	Presentation of FMS SCENARIO – 2 Justification - 3	5 min
7	About Adaptive Control Discussion of Machining operations Feasibility	1 2 2	5 min
8	FMS FMC	2 2 Compare - 1	4 min
9	PTB = POINT/INTOF, LIN1, LIN2	Exact answer – 5 Marks Approx - 2	3 min

Part C (Q x M = Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question

10	General layout of FMS List the Components Component discussionS	2.5 2.5 2.5	10
11	Types of flexibilities in FMS	7.5	10
12	Program given below	7.5	10

Roll No.													

PRESIDENCY UNIVERSITY
BENGALURU

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

SCHOOL OF ENGINEERING

Sem & AY: Odd Sem 2019-20 | **Date**: 18.11.2019

Course Code: MEC 310 | **Time**: 9:30 AM TO 10:30 AM

Course Name: FLEXIBLE MANUFACTURING SYSTEMS | **Max Marks**: 40

Program & Sem: B.Tech, (MEC) & VII (DE) | **Weightage**: 20%

Instructions:

I. Answer all questions sequentially

II. Legible presentation & Figures to the right indicate full marks.

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries one mark. (5Qx1M=5M)

1. In material handling devices, the RGV Stands (C.O.NO.3)[Knowledge]
   a. Rail Guided Vehicle
   b. Remote Guided Vehicle
   c. Relay Guided Vehicle
   d. None of these
2. Cranes are used for _________ lift movement of material and Hoists are used for _________ lifting. (C.O.NO.3)[Knowledge]
   a. Vertical, Vertical
   b. Horizontal, Vertical
   c. Horizontal, Horizontal
   d. Vertical, Horizontal
3. Suggest the correct material handling system for the situation like distance involved, components involved are relatively large. (C.O.NO.3)[Knowledge]
   a. AGV, b. Conveyor systems, c. Robot d. None of these
4. Tool management is getting the right _______ to the right _______ at the right _____ (C.O.NO.4)[Application]
   a. time, tool, place, b. time, place, tool, c. place, tool, time, d. tool, place, time
5. During Fault sensing a B&K type 2671 microphone was used for _________ (C.O.NO.4)[Application]
   a. measure the machine tool vibrations in cutting
   b. measure the cutting forces
   c. precision sound level measurement
   d. loading and unloading of the tools

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries five marks. (4Qx5M=20M)

6. Explain the steps involved in the development of coding system for GT. (C.O.NO.2)[Comprehension]

7. Enlist the various functions of automated material handling equipment (C.O.NO.3)[Comprehension]
8. Show the block diagram of Material Handling in the Production System and explain the components (C.O.NO.3)[Comprehension]
9. Factors to be considered for deciding MH Equipment (C.O.NO.3)[Comprehension]
10. Classify and describe the tool strategies used in tool management (C.O.NO.4)[Comprehension]

Part C [Problem Solving Questions]

Answer both the Questions. Each Question carries seven and half marks. (2Qx7.5M=15M)

11. A small electrical appliance is to be produced on a single model assembly line. The work content of assembling the product has been reduced to the work elements given in the table. The table also lists the standard times that have been established for each element as well as the precedence order in which they are to be performed.

    The line is to be balanced for an annual demand of 100000 unit/yr. The line will operate 50wk/yr, 5 shifts/wk and 7.5 hr/shift. There will be one worker per each station. The service time to which the line must be balanced is assumed as 1.

    Solve line balancing problem by Largest Candidate Rule Method. (C.O.NO.3)[Application]

Table 1 – Work Elements

No.	Work Element Description	Tek (min)	Must be preceded by
1	Place frame in work holder and clamp	0.2	-
2	Assemble plug, grommet to power cord	0.4	-
3	Assemble brackets to frame	0.7	1
4	Wire power cord to motor	0.1	1, 2
5	Wire power cord to switch	0.3	2
6	Assemble mechanism plate to bracket	0.11	3
7	Assemble blade to bracket	0.32	3
8	Assemble motor to brackets	0.6	3, 4
9	Align blade and attach to motor	0.27	6, 7, 8
10	Assemble switch to motor bracket	0.38	5, 8
11	Attach cover, inspect, and test	0.5	9, 10
12	Place in tote pan for packing	0.12	11

12. Discuss with illustration about the modular fixtures applications in FMS and its economics. (C.O.NO.4)[Application]

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

Semester: Seven
Course Code: MEC 310
Course Name: Flexible Manufacturing Systems

Date: 18/11/2019
Time: 9.30-10.30
Max Marks: 40
Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO	CO.NO	Module Number /Module Title	Memory recall type [Marks allotted] Bloom's Levels			Thought provoking type [Marks allotted] Bloom's Levels			Problem Solving type [Marks allotted]			Total Marks
			K			C			A			
1		1	L									1
2		1	L									1
3		1		M								1
4		2								M		1
5		2							L			1
6		1					M					5
7		1					M					5
8		2					M					5
9		1						H				5
10		1				L						7.5
11		2					M					7.5
12		1									H	7.5
	Total Marks		2	1		7.5	22.5	5	1	1	7.5	40

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

SCHOOL OF ENGINEERING

SOLUTION

Semester: Seven

Course Code: MEC 310

Course Name: Flexible Manufacturing Systems

Date: 18/11/2019

Time: 9.30-10.30

Max Marks: 40

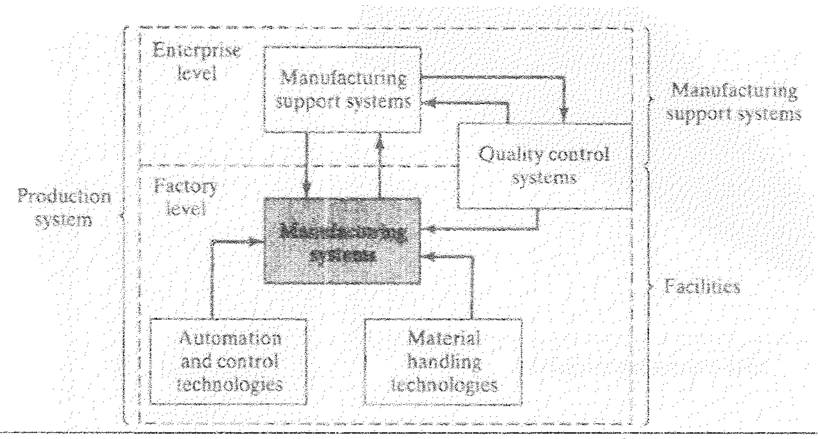
Weightage: 20%

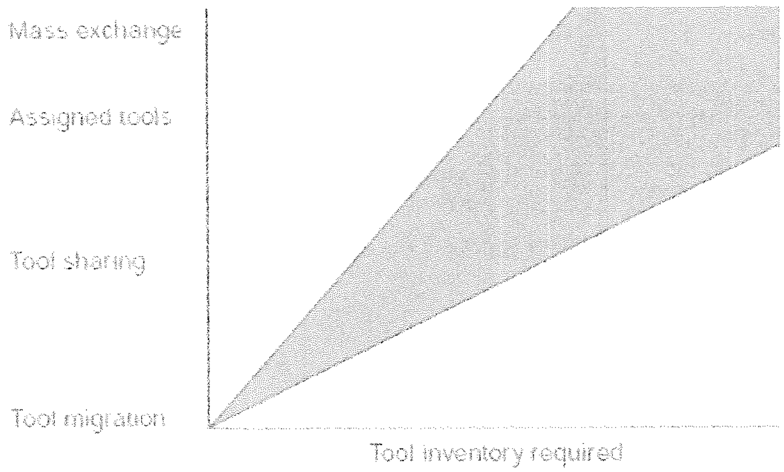
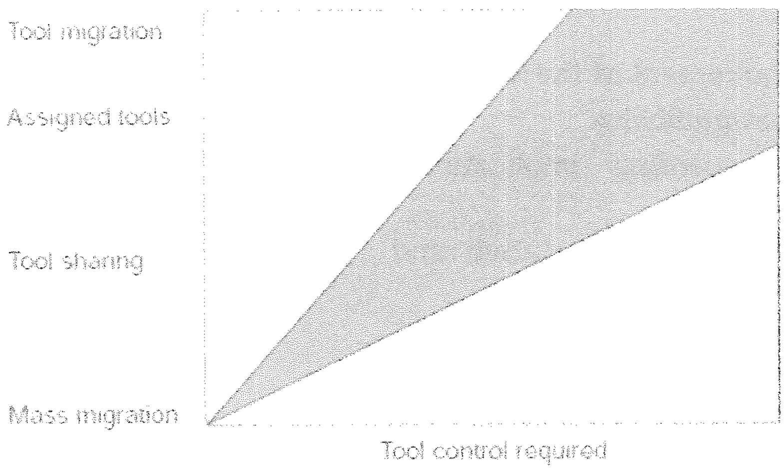
Part A (5Q x 1M =5 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	a	01 Mark	2 min
2	b	01 Mark	2 min
3	a	01 Mark	2 min
4	d	01 Mark	2 min
5	c	01 Mark	2 min

Part B (5Q x 4M =20 Marks)

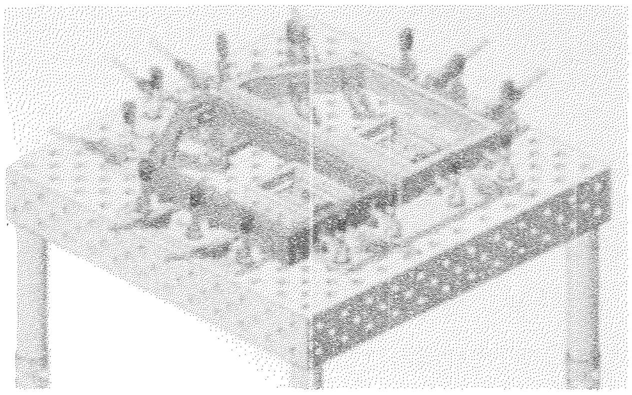
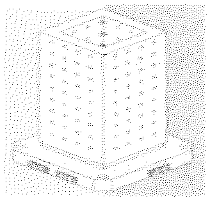
Q No	Solution	Scheme of Marking	Max. Time required for each Question
6	**Most classification and coding systems are based on one of the following:** –Part design attributes –Part manufacturing attributes –Both design and manufacturing attributes **Part Design Attributes** •Major dimensions •Basic external shape •Basic internal shape Length/diameter ratio •Material type	Definition 1 Marks 1.5 Marks	5 min

	•Part function • Tolerances •Surface finish **Part Manufacturing Attributes** •Major process •Operation sequence •Batch size •Annual production •Machine tools •Cutting tools •Material type	1.5 Marks	
7	Refer: 7**Answer**	At least 4 Applications (4 x 1= 4 marks)	5 min
8		Block Diagram – 2 Component Discussion – 2 Marks	5 min
9	• **Speed and frequency at which transfer must occur.** • **Volume and weight requirement of the load.** • **Routing flexibility and extendibility.** • **Safety requirements, guarding implications, maintenance.** • **Accuracy required of component location and system docking.**	Each factor 1 marks (4 x 1=4)	5 min
10	Various tool strategies exist within the framework of tool management that requires examination. Each has its advantages and disadvantages as well as particular application for an FMS. The tool strategies employed in FMS are: • Mass Exchange • Tool sharing • Tool migration • Assigned tools **1 Mass Exchange** The mass exchange strategy is removing all the tools in each machine tool matrix at the completion of specific production requirements and replacing them with the new part required for tooling **2 Tool Sharing**	Explanation – 2 Marks	5 min

	The tool-sharing concept permits the logical sharing of tools within the framework of affixed production period and workpiece requirements. Common tooling among the fixed production requirements is recognized, identified and shared among the various parts to be manufactured in the fixed production period. 3 **3. Tool Migration** • The tool migration strategy is basically an extension of the mass exchange and tool sharing theory. **4 Assigned Tools** The above 3 strategies previously discussed assumed that a given set of workpiece be machined at a specific machine tool   	Diagram – 2 Marks	

Part C (2Q x 7.5M =15 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question

11	Refer: **11 Answer**	Calculation 3 Marks Cell Formation Network - 3.5 Marks	15 min
12	A modular fixturing system is composed of standardized components that allow for flexible arrangement and interchangeability between different applications. The versatility of the components makes it a viable alternative to traditional fixturing methods because a single modular fixture system is capable of doing the same work as numerous dedicated fixturing systems. **Tooling Plates and Blocks** The fundamental components of a workholding or modular fixturing system are the tooling plates or tooling blocks, which are commonly referred to as fixture plates, grid blocks, or tombstones.   Modular fixture Tooling plate The multipurpose holes (MTP holes) on both the tooling plates and blocks allow for accurate aligning or fastening of other components in a number of locations. Flex plates offer the ability to work on any given fixture away from the machine, free from any space constraints. A flex base plate resides on a machining center pallet and will accept other flex tooling plates or blocks to be fastened onto it, which allows for fast changeover between applications. The two tapered pins allow for accurate and consistent locating when mounting other flex plates to the base.	Description – 3 Marks Diagrams – 3 Marks Economics – 1.5 Marks	15 min

7 Answer

Summary of Features and Applications of Five Categories of Material Handling Equipment

Material Handling Equipment	*Features*	*Typical Applications*
Industrial trucks, manual	Low cost Low rate of deliveries/hr	Moving light loads in a factory
Industrial trucks, powered	Medium cost	Movement of pallet loads and palletized containers in a factory or warehouse
Automated guided vehicle systems	High cost Battery-powered vehicles Flexible routing Nonobstructive pathways	Moving pallet loads in factory or warehouse Moving work-in-process along variable routes in low and medium production
Monorails and other rail guided vehicles	High cost Flexible routing On-the-floor or overhead types	Moving single assemblies, products, or pallet loads along variable routes in factory or warehouse Moving large quantities of items over fixed routes in a factory or warehouse
Conveyors, powered	Great variety of equipment *In-floor, on-the-floor, or overhead* Mechanical power to move loads resides in pathway	Moving products along a manual assembly line Sortation of items in a distribution center
Cranes and hoists	Lift capacities ranging up to more than 100 tons	Moving large, heavy items in factories, mills, warehouses, etc

11 Answer

Solution: (a) The total work content time is the sum of the work element times in Table 17.4.

$$T_{wc} = 4.0 \text{ min}$$

(b) Given the annual demand, the hourly production rate is

$$R_p = \frac{100{,}000}{50(5)(7.5)} = 53.33 \text{ units/hr}$$

(c) The corresponding cycle time T_c with an uptime efficiency of 96% is

$$T_c = \frac{60(0.96)}{53.33} = 1.08 \text{ min}$$

(d) The theoretical minimum number of workers is given by Eq. (17.9):

$$w^* = \left(\text{Min Int} \geq \frac{4.0}{1.08} = 3.7\right) = 4 \text{ workers}$$

(e) The available service time against which the line must be balanced is

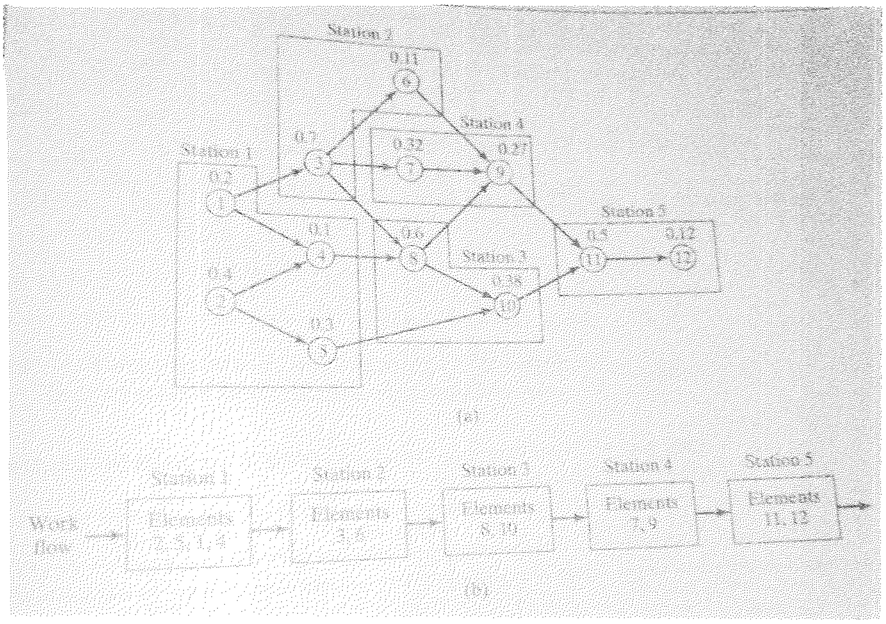
$$T_s = 1.08 - 0.08 = 1.00 \text{ min.}$$

TABLE 15.5 Work Elements Arranged According to T_{ek} Value for the Largest Candidate Rule

Work Element	T_{ek} (min)	Preceded By
3	0.7	1
8	0.6	3, 4
11	0.5	9, 10
2	0.4	—
10	0.38	5, 8
7	0.32	3
5	0.3	2
9	0.27	6, 7, 8
1	0.2	—
12	0.12	11
6	0.11	3
4	0.1	1, 2

...to the Largest Candidate Rule

Station	Work Element	T_{ek} (min)	Station Time (min)
1	2	0.4	
	5	0.3	
	1	0.2	
	4	0.1	1.0
2	3	0.7	
	6	0.11	0.81
3	8	0.6	
	10	0.38	0.98
4	7	0.32	
	9	0.27	0.59
5	11	0.5	
	12	0.12	0.62



Roll No												

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PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Semester: Odd Semester. 2019-20 | **Date**: 24 December 2019

Course Code: MEC 310 | **Time**: 9:30 AM to 12:30 PM

Course Name: FLEXIBLE MANUFACTURING SYSTEMS | **Max Marks**: 80

Program & Sem: B.Tech (MEC) & VII (DE-IV) | **Weightage**: 40%

Instructions:

i. Answer all questions
ii. Answer all questions sequentially
iii. Legible Presentation & Figures to the right indicate full marks

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries 2 marks. (5Qx2M=10M)

1. State some Mathematical Models used in Production Performance (C.O.No.1) [Knowledge]

2. Name the types of major flexibilities and define any one of them (C.O.No.2) [Knowledge]

3. Define and name the types of AGV. (C.O.No.3) [Knowledge]

4. What are the practices to be considered for effective control of tools? (C.O.No.4) [Knowledge]

5. Show in graph, the percentage of savings by the application of cellular manufacturing for various parameters. (C.O.No.5) [Knowledge]

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries 10 marks. (4Qx10M=40M)

6. The table shows machine component incidence matrix for 4M x 5C problem. Form cells using single linkage cluster analysis method using similar coefficient method

		Components				
		1	2	3	4	5
Machines	1	1	0	1	0	0
	2	0	1	1	0	1
	3	1	0	0	1	0
	4	0	0	1	0	1

(C.O.No.2) [Application]

7. Compare the traditional process layout and GT cellular layout with neat diagrams. (C.O.No.2) [Application]

8. What is tooling requirements of an FMS? Explain the four areas of adequate tool management system to fulfill the tooling requirements. (C.O.No.4) [Comprehension]

9. Discuss a typical four phases of FMS installation (C.O.No.5) [Comprehension]

Part C [Problem Solving Questions]

Answer both the Questions. The Question carries 15 marks. (2Qx15M=30M)

10. A small electrical appliance is to be produced on a single model assembly line. The work content of assembling the product has been reduced to the work elements given in the table. The table 1 also lists the times for each element and the precedence order in which they are to be performed. There will be one worker per each station. The service time to which the line must be balanced is assumed as 1. (C.O.No.3) [Application]

Solve line balancing problem by KILBRIDGE AND WESTER METHOD

Table 1

No.	Work Element Description	T_{ek} (min)	Must be preceded by
1	Place frame in work holder and clamp	0.2	-
2	Assemble plug, grommet to power cord	0.4	-
3	Assemble brackets to frame	0.7	1
4	Wire power cord to motor	0.1	1, 2
5	Wire power cord to switch	0.3	2
6	Assemble mechanism plate to bracket	0.11	3
7	Assemble blade to bracket	0.32	3
8	Assemble motor to brackets	0.6	3, 4
9	Align blade and attach to motor	0.27	6, 7, 8
10	Assemble switch to motor bracket	0.38	5, 8
11	Attach cover, inspect, and test	0.5	9, 10
12	Place in tote pan for packing	0.12	11

11. (i). Examine lean production and mass production [5M]

(C.O.No.5) [Comprehension]

(ii). Explain the two types of Kanban system with neat diagram [10M]

(C.O.No.5) [Comprehension]

SCHOOL OF ENGEERING

GAIN MORE KNOWLEDGE REACH GREATER HEIGHT

END TERM FINAL EXAMINATION

Extract of question distribution [outcome wise & level wise]

Q.No.	CO.NO (% age of CO)	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	A	
A1	2.5 % C.O.01	Module 1/ mathematical model	2			2
A2	2.5 % C.O.02	Module 2/ types of flexibility	2			2
A3	2.5 % C.O.03	Module 3/AGV	2			2
A4	2.5 % C.O.04	Module 4/Control of cutting tools	2			2
A5	2.5 % C.O.05	Module 5/Economic Justification	2			2
B6	12.5 % C.O.02	Module 2/ single linkage cluster analysis			10	10
B7	12.5 % C.O.02	Module 2/Group Technology			10	10
B8	12.5 % C.O.04	Module 4/tool management		10		10
B9	12.5 % C.O.05	Module 5/FMS Installation		10		10
C10	18.75 % C.O.03	Module 3/Line Balancing			15	15
C11	18.75 % C.O.05	Module 5/lean and kanban		5+10		15
	Total Marks		10	35	35	

K =Knowledge Level C = Comprehension Level, A = Application Level

C.O WISE MARKS DISTRIBUTION:

CO 01: 2.5 MARKS

CO 02: 27.5 MARKS

CO 03: 20.25 MARKS

CO 04:15 MARKS

CO 05: 33.75 MARKS

Note: While setting all types of questions the general guideline is that about 60% of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

I hereby certify that all the questions are set as per the above guidelines.

Faculty Signature:

Reviewer Commend:

Answer Scheme

SCHOOL OF ENGINEERING

SOLUTION

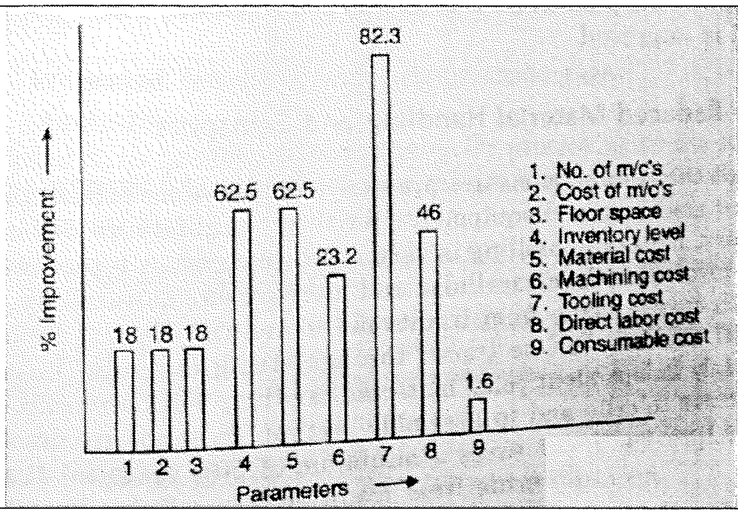
GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

Semester: Odd Sem. 2019-20
Course Code: MEC 310
Course Name: FLEXIBLE MANUFACTURING SYSTEMS
Program & Sem: B.Tech (Mech), 7

Date: 24.12.2019
Time: 3 HRS
Max Marks: 80
Weightage: 40%

Part A (5Q x 2M = 10 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	• Operation Cycle Time T_c ($T_c = T_o + T_h + T_{th}$) • **Batch production** batch processing time (min) - Tb=Tsu + QTc job shop production (Q = 1), the production time per work unit is the sum of setup and operation cycle times: $T_p = T_{su} + T_c$ • Production capacity PC = nSHRp PC = production capacity of the facility (output units/wk), n = number of work centers producing in the facility. S = number of shifts per period (shift/wk), H = hr/Shift (hr), and Rp= hourly production rate of each work center (output units/hr) • Ulilization: U=Q/PC U = utilization of the facility, Q = actual quantity produced by the facility during a given time period(pc/wk),and PC - production capacity for the same period (pc/wk.) • Availability is a common measure of reliability for equipment A = (MTBF-MTTR)/MTBF where A = availability. MTBF = mean time between failures (hr) and MTTR = mean time to repair (hr), Availability is typically expressed as a percentage	0.5 marks per formula	5 min
2	**BASIC** Machine Flexibility Material Handling Flexibility Operation Flexibility **SYSTEM** Volume Flexibility Routing Flexibility Process Flexibility Product Flexibility **AGGREGATE** Program Flexibility Production Flexibility Market Flexibility	0.5 marks per answer	5 min
3	An automated guided vehicle system (AGVS) is a material handling system that uses independently operated, self-propelled vehicles guided along defined pathways.	Definition – 1 mark	5 min

	The vehicles are powered by on-board batteries that allow many hours of operation (8-16 hr is typical) between recharging. Types of AGVS Automated guided vehicles can be divided into the following three categories: (1) Driverless trains. (2) Pallet trucks and (3) Unit load carriers	Types – 1 Mark	
4	• Review cutting tool and indexable insert inventory and get control of usage. • Review cutting tool purchasing practices. • Reduce dependency on specialized, nonstandard tooling. • As perishable tools are checked out from in-house tool-stores, they ultimately find their way into operators tool cabinets carried to extremes.	0.5 mark/point	5 min
5		Graph – 1 mark Prameters – 1 mark	5 min

Part B

(0Q x 0M = 0 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
6	Similarity Coefficient is calculated between machines using equation S=a/(a+b+c) Compute Similarity Coefficient between machines 1,2 (i.e i=1, j=2)	Basic Calculation-7 marks Cell formation – 3 marks	20 min

In this case,

a = Total number of components visiting both machines
= 1(component 3)

b = Number of components visiting machine 1 but not machine 2
= 1 (component 1)

c = Number of components visiting machine 2 but not machine 1
= 2 (component 2 and 5)

We know that

$$S_{ij} = \frac{a}{(a+b+c)} = \frac{1}{(2+1+2)} = 0.2$$

Similarly, compute similarity coefficient between other pair of machines. Figure 2.11 shows similarity coefficient matrix.

		M/c j 1	2	3	4
M/c i	1	0	0.2	0.33	0.33
	2		0.0	0.00	0.67
	3			0.00	0.00
	4				0.00

Similarity coefficient matrix.

As seen from Figure as the number of common operations between machines are increasing, value of similarity coefficient will also increase (for example $S_{2,4}$). If the machines do not have common machining operations, it is obvious that similarity coefficient will be zero (for example $S_{2,3}$).

Step 2:

As seen from Figure 2.11 machines 2 and 4 have high similarity coefficient. Group these two machines together and update the matrix.

Now, compute similarity between ungrouped machines (i.e., 1, 3) and grouped machines (i.e., 2, 4).

Compute similarity between machine 1 and group (2, 4) using Eq. as:

$$S_{1,(2,4)} = \text{Max}\ \{S_{1,2}, S_{1,4}\} = \text{Max}\ \{0.2, 0.33\} = 0.33$$

Similarly

$$S_{(2,4),3} = \text{Max}\ \{S_{2,3}, S_{4,3}\} = 0.00$$

The updated matrix using the aforementioned procedure is shown in Figure

	1	2, 4	3
1	0	0.33	0.33
2, 4		0.00	0.00
3			0.00

FIGURE 2.12 Updated matrix.

The maximum value in the table corresponds to machines 1, 3. Hence, form the new group with machines 1 and 3. The revised matrix after grouping machines 1 and 3 is shown in Figure 2.13.

	2, 4	1, 3
2, 4	0.00	0.33
1, 3	0.33	0.00

FIGURE 2.13 Revised matrix

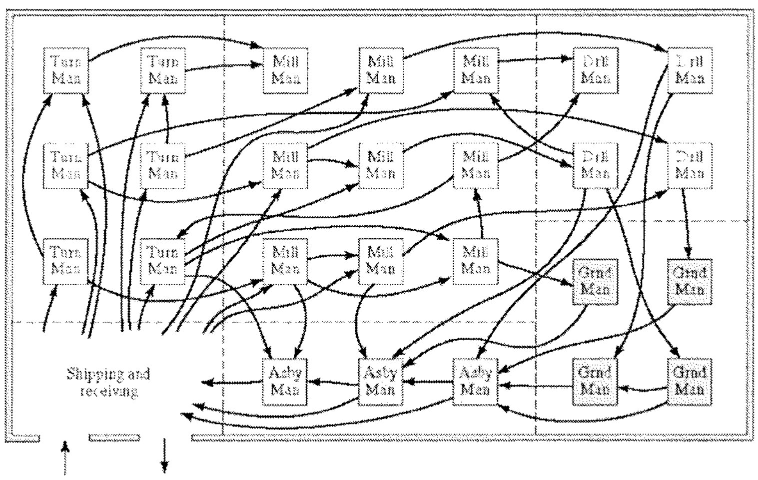
Since, no machines are left, stop the procedure. The final solution is:

Cell 1: 2, 4

Cell 2: 1, 3

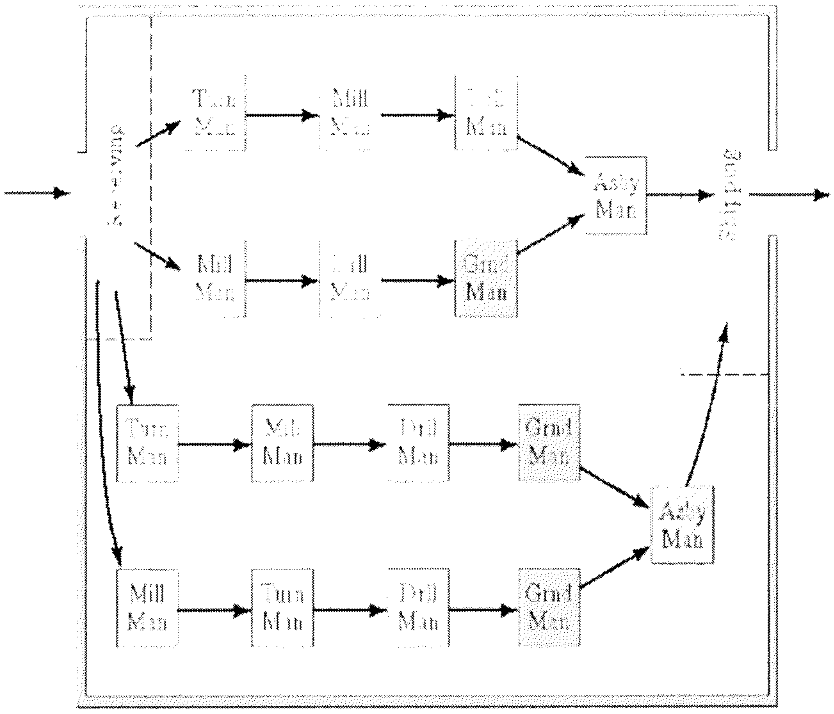
<table>
<tr>
<td>7</td>
<td>

Traditional Process Layout



Cellular Layout Based on Group Technology
Each cell specializes in producing one or a limited number of part families

</td>
<td>Comp – 4 marks
Diagram – 3+3 = 6 marks</td>
<td>20 min</td>
</tr>
</table>

			
8	Generally, tool management is getting the right tool to the right place at the right time. Having an acceptable tool management system to fulfill the tooling requirements of an FMS means adequately addressing the following four areas: **1. Tool Room Service:** Providing adequate tool room service does not directly affect the machine tools that make up an FMS, but is essential to system effectiveness. Tool room service is a necessary support function dealing principally with preparing, servicing, organizing and controlling the vast array of perishable tools, inserts, tool holders and tool components. The principal elements of tool room service are: • Buildup and teardown of tool assemblies. • Inventors of tools, tool components and related tool assembly instructions • Control of idle (returning and least used) tool assemblies along with • Determining tool disposition (what to do with these tools). • Actively maintaining machine tool data for the remaining tool life of returning and idled tool assemblies. **2 Tool Delivery** Tool delivery addresses the tool management function relative to moving the tools between the tool room and the various tool magazines of each machine tool in the FMS. This includes transporting the tools to and from the machine tool requiring those tools, and loading and unloading the tool magazines once the tool arrive at the machines. If the demand for tools based on the variety	Explain – 6 marks Clarity – 4 marks	20 min

	of part mix is high enough, complete automation of the tool delivery and distribution function may be necessary. **3 Tool Allocation and Data Flow** • Tool allocation and data flow are two of the most difficult aspects of tool management to manage and control • Tool allocation is essentially assigning and controlling the total number of tools required for each machine to process the previously defined FMS part spectrum. It is based on specific part process plans, machine programs and machining methodology along with the varying part mix and volumes that could be running through the system at any given time. • Controlling the tool data flow relative to the allocated tools requires that the MCU (Machine control unit) would assume tool data transfer from the present area as tools are automatically gauged, identified and entered into the FMS tool system data base. **4 Fault Sensing** Fault sensing is monitoring and detecting cutting tool problems at each machine. This involves electromechanical and optical sensing and detection of worn and broken tools along with absence of tools or misplacements. Each tool is offset to a contact and non-contact sensor. Each time it is used in order to validate tool presence, correctness and condition. Replacements should be available for the broken tools.		
9	A typical FMS installation that might be accomplished in 4 phases are: **Phase 1:** Underground utilities, chip bins and a chip compactor, Machine foundation slabs, main FMS manufacturing floor would be reinforced and concrete poured and cured **Phase 2**: AGV lines are cut into the floor from the floor marking templates, Guidepath wire embedded in the floor cuts and epoxy sealed, elevated computer room is erected, wiring is pulled, Compressed air and electrics are run to machine power drop locations and the overhead crane system is installed. Additionally a central coolant flume and chip recovery system, chip conveyor and chip compactor are run off and operationally checked **Phase 3**: machines placed in their proper positions, Electrical and compressed air lines are hooked up, Machine tools are quickly aligned, and operational features (machine and control) are thoroughly checked out, Machine cutting tests, generally conducted, witnessed and approved by the purchaser project manager in the machine tool vendor's plant, are conducted again once machines are installed in the customer's plant FMS host and the AGV computer system are also installed, operating and application software is installed, FMS computer and software testing and debugging, AGVs are installed, checked out, operated manually and linked to the computer system. **Phase 4**: Adding the inspection machine is one of the next important modules to add to the FMS. Include installation, load-unload stations, fixture and tool build stations and the tool delivery module, If ASRS in included, this could be installed some time during this phase. the purchaser would be installing perimeter guarding, eye wash stations, fire extinguishing equipments and other safety equipment along with painting guide path markings on the factory floor	List – 4 marks Explanation – 6 marks	20 min

Part C

(0Q x 0M = 0Marks)

<table>
<tr><th>Q No</th><th>Solution</th><th>Scheme of Marking</th><th>Max. Time required for each Question</th></tr>
<tr><td>10</td><td>

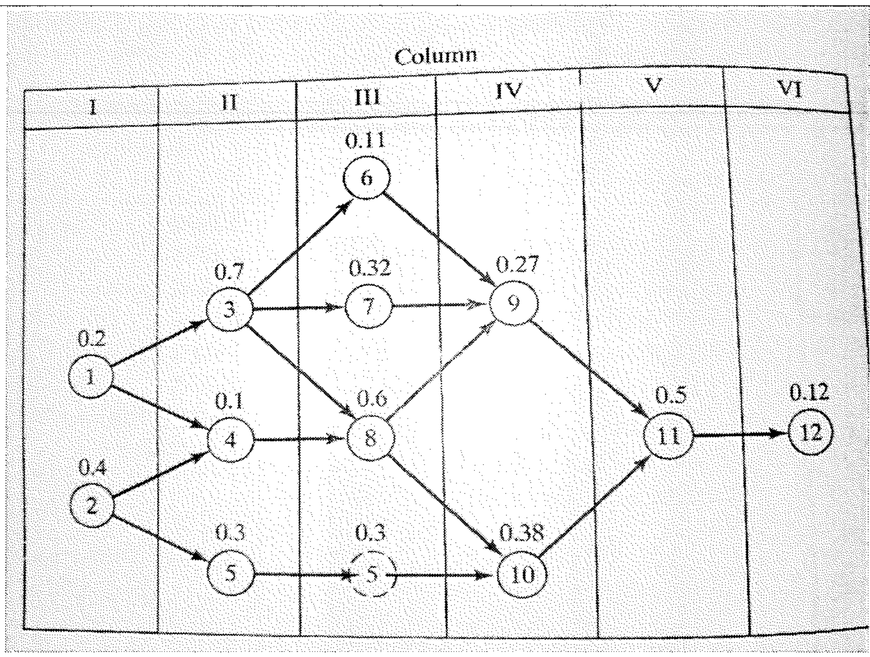
TABLE 15.7 Work Elements Listed According to Columns from Figure 15.7 for the Kilbridge and Wester Method

<table>
<tr><th>Work Element</th><th>Column</th><th>T_{ek} (min)</th><th>Preceded By</th></tr>
<tr><td>2</td><td>I</td><td>0.4</td><td>-</td></tr>
<tr><td>1</td><td>I</td><td>0.2</td><td>-</td></tr>
<tr><td>3</td><td>II</td><td>0.7</td><td>1</td></tr>
<tr><td>5</td><td>II, III</td><td>0.3</td><td>2</td></tr>
<tr><td>4</td><td>II</td><td>0.1</td><td>1, 2</td></tr>
<tr><td>8</td><td>III</td><td>0.6</td><td>3, 4</td></tr>
<tr><td>7</td><td>III</td><td>0.32</td><td>3</td></tr>
<tr><td>6</td><td>III</td><td>0.11</td><td>3</td></tr>
<tr><td>10</td><td>IV</td><td>0.38</td><td>5, 8</td></tr>
<tr><td>9</td><td>IV</td><td>0.27</td><td>6, 7, 8</td></tr>
<tr><td>11</td><td>V</td><td>0.5</td><td>9, 10</td></tr>
<tr><td>12</td><td>VI</td><td>0.12</td><td>11</td></tr>
</table>

TABLE 15.8 Work Elements Assigned to Stations According to the Kilbridge and Wester Method

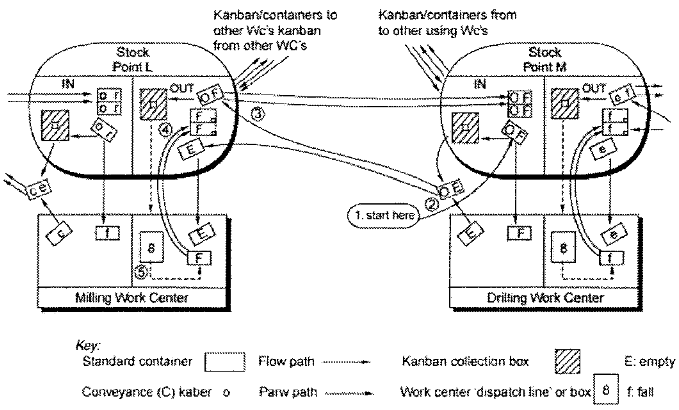
<table>
<tr><th>Station</th><th>Work Element</th><th>Column</th><th>T_{ek} (min)</th><th>Station Time (min)</th></tr>
<tr><td>1</td><td>2</td><td>I</td><td>0.4</td><td></td></tr>
<tr><td></td><td>1</td><td>I</td><td>0.2</td><td></td></tr>
<tr><td></td><td>5</td><td>II</td><td>0.3</td><td></td></tr>
<tr><td></td><td>4</td><td>II</td><td>0.1</td><td>1.0</td></tr>
<tr><td>2</td><td>3</td><td>II</td><td>0.7</td><td></td></tr>
<tr><td></td><td>6</td><td>III</td><td>0.11</td><td>0.81</td></tr>
<tr><td>3</td><td>8</td><td>III</td><td>0.6</td><td></td></tr>
<tr><td></td><td>7</td><td>III</td><td>0.32</td><td>0.92</td></tr>
<tr><td>4</td><td>10</td><td>IV</td><td>0.38</td><td></td></tr>
<tr><td></td><td>9</td><td>IV</td><td>0.27</td><td>0.65</td></tr>
<tr><td>5</td><td>11</td><td>V</td><td>0.5</td><td></td></tr>
<tr><td></td><td>12</td><td>VI</td><td>0.12</td><td>0.62</td></tr>
</table>

</td><td>Stage – 1 – 3 marks
Table 1 – 4 marks
Table 2 – 4 marks
Cell Formation – 4 marks</td><td>30 min</td></tr>
</table>



11

Mass Production	*Lean Production*
inventory buffers	Minimum waste
Just-in-case deliveries	Minimum inventory Just-in-time deliveries
Acceptable quality level (AQL)	Perfect first-time quality
Taylorism	Worker teams
Maximum efficiency	Worker involvement Flexible production systems
If it is n't broke, don't fix it	Continuous improvement

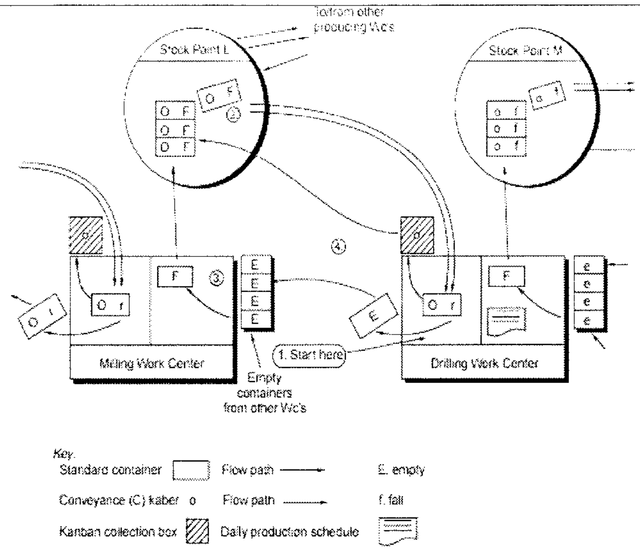


Dual card Kanban for milling and drilling process

Comparison – 5 marks

Kanban types – 2 marks
Each drawing – 4 +4 = 8 marks

30 min

	 Single card kanban system		