



MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

FIFTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM 508: FLEXIBLE MANUFACTURING SYSTEMS

DATE: _____ **TIME:** _____

INSTRUCTIONS

- i. This examination contains **FIVE** questions.
- ii. You are required to answer **THREE** questions.
- iii. Question one is **COMPULSORY** and carries 3 Marks while the rest carry 2 Marks each.
- iv. Answer any two of the remaining questions

QUESTION ONE (30 MARKS)

- a) Briefly differentiate the following terms as used in Flexible manufacturing system
 - a. Flexible manufacturing cell and flexible manufacturing system (2 marks)
 - b. Group technology and random flexible manufacturing system (2 marks)
- b) With a well labeled diagram, prepare a general layout of Flexible Manufacturing System (FMS) and explain each component separately (6 marks)
- c) In which areas of FMS is the tool management applied effectively. (4 marks)
- d) Briefly describe the functions of automated material handling and storage systems. (6 marks)
- e) In order to determine the number of vehicles required to meet the demand for a particular automated guided vehicle system. The system must be capable of making 40 deliveries per hour. The following are the data of performance characteristics of the system:
 - Vehicle Velocity = 45 m/min.
 - Average distance traveled/delivery = 135m
 - Pick up time = 45 sec.
 - Drop off time = 45 sec.
 - Average distance traveling empty = 90 m

Traffic factor = 0.9

- i. Determine the number of vehicles required to satisfy the delivery demand (7 marks)
- ii. Also, determine the handling system efficiency. (3 marks)

QUESTION TWO (20 MARKS)

- a) Explain the three levels of manufacturing flexibility (6 marks)
- b) The exponential adoption of FMS after its inception led the industrialists to suggest that “the strategic majority of production of the metal-working industries in the industrialized countries will be produced by FMS or similar systems by the year 2000. However, in a large (>1000 firms) survey of metal working firms, it was found that less than 5% of those plants with computerized automation have an FMS and that FMS constituted only 1.5 % of the total number of installations of computerized automation. Why are there still so few FMS in the world given that small-batch engineering production is a significant proportion of manufacturing output? (6 marks)
- c) Using the concept of FMS including different cell components as listed in Table Qn. 2 (c), design a typical Mechanical Engineering CAD/CAM laboratory layout and briefly explain how the system works (8 marks)

Table Qn. 2 (c)

<i>Name of Device</i>	<i>Quantity and description</i>
5 Axis Robot	2
Personal Computer	3
Universal belt Conveyor	1
Flexible Conveyor	1
PLC device	2
Sensors	9(4 Contact Sensors,3 Optical sensors,1 Metal detector and 1 Non-Metal Detector)
Motors	3(1 Emergency stop and run push button)

QUESTION THREE (20 MARKS)

- a) Describe the key roles of software in FMS (4 marks)
- b) Group technology (GT), like JIT is a journey, not a destination. It involves continuous improvement and structured discipline and must be a fundamental building block of a cell or system if the real benefits of automation are to be achieved.
- With a suitable illustration explain the term group technology (2 marks)
 - State three advantages and one disadvantage of group technology (4 marks)
- c) Four machines will constitute a GT cell. The from-to data for the machines are as follows.

Table Qn. 3 (a)

		<i>From</i>			
		<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
To	1	0	5	0	25
	2	30	0	0	15
	3	10	40	0	0
	4	10	0	0	0

- Determine the sequence of machine according to/from ratio (3 marks)
- Construct a flow diagram (4 marks)
- Where do the parts enter cell and exit the cell 50 parts enter at machine 3, 20 parts after machine 1 leaves and 30 parts after machine 4 leave. (3 marks)

QUESTION FOUR (20 MARKS)

- a) What do you understand by scheduling in FMS? (1 mark)
- b) Current time is 30. Machine Q has just finished a job, and it is time to select its next job. Table Qn. (b) provides information on the four jobs available. For each of the following dispatching rules, determine the corresponding sequence.

Table Qn. 2 (b) Machine job data

Job	Arrival to the system	Arrival at Q	Due date	Operation (machine P _{i,j})		
				1	2	3
1	5	10	30	(Q,5)	(P,1)	(S,6)
2	0	5	20	(P,5)	(Q,3)	(R,2)
3	9	9	10	(R,3)	(S,2)	(Q,2)
4	0	8	25	(T,6)	(Q,4)	(R,4)

- Earliest due date (EDD) (1 mark)
- First come, first served (FCFS) (2 marks)
- First in system, first served (FISFS) (2 marks)

- c)
- i. Differentiate between open and closed loop control system in FMS (3 marks)
 - ii. With the help of a diagram briefly describe the main elements in a closed loop control system in a FMS (8 marks)
- d) Depending upon the problem environment, many new trends have been accommodated with FMS to accord with the requirements of highly customized production, high flexibility, low production cost, and low lead time. Explain at least TWO of the recent trends in FMS. (3 marks)

QUESTION FIVE (20 MARKS)

- a) Briefly explain the following types of FMS software modules
- i. Data distribution and processing (2 marks)
 - ii. System diagnostics and maintenance (2 marks)
 - iii. Tool management (2 marks)
 - iv. Traffic management and control (2 marks)
- b) With the help of a flowchart explain the general phases of simulation in FMS (4 marks)
- c) “Extra quality means extra cost,” “cheap is expensive and quality is free,” demystify these statements with reference to quality of products in a FMS industry. (3 marks)
- d) Briefly explain the significance of quality control in FMS (5 marks)