NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

BACHELOR OF ENGINEERING (HONS) DEGREE INDUSTRIAL AND MANUFACTURING ENGINEERING

MANUFACTURING SYSTEMS III

TIE 5101

FIRST SEMESTER MAIN EXAMINATION

DECEMBER 2014

This examination paper consists of 4 pages

Time Allowed: **3 hours**

Total Marks: **100**

Special Requirements: **Nil**

Examiner's Name: **Eng. T R Chikowore**

INSTRUCTIONS AND INFORMATION TO CANDIDATES

1. Answer any five (5) questions, at least TWO from each section
2. Each question carries 20 marks

MARK ALLOCATION

QUESTION	MARKS
1.	20
2.	20
3.	20
4.	20
5.	20
6	20
7	20
TOTAL	100

SECTION A: FLEXIBLE MANUFACTURING SYSTEMS (FMS)

Question 1

An agile manufacturer is one who is fastest to market, operates with the lowest total cost and has the greatest ability to delight its customers. Making reference to the types of flexibilities discuss how manufacturers use Flexible Manufacturing Systems (FMSs) to achieve this agility. [20]

Question 2

A Flexible Machining System (FMS) consists of two machining workstations and a load/unload station. Station 1 is the load/unload station. Station 2 performs milling operations and consists of two servers (two identical CNC milling machines). Station 3 has one server that performs drilling (one CNC drill press). Immediately after drilling, parts are checked for quality at Station 4 which has a single server before unloading. Inspection for quality is done through sampling and one in every ten parts is inspected. The stations are connected by a part handling system that has four work carriers. The mean transport time is 2.5 min. the FMS produces two parts, A and B. The part mix fractions and the process routing for the two parts are presented in the Table Q2 below. The operation frequency is 1.0 for all other operations.

Table Q2: Part Type Data for Question 2

Part j	**Part Mix p_j**	**Operation k**	**Description**	**Station i**	**Process Time t_{ijk} (min)**
A	0.55	1	Load	1	2
		2	Mill	2	10
		3	Drill	3	15
		4	Inspect	4	0.2
		5	Unload	1	2
B	0.45	1	Load	1	2
		2	Mill	2	30
		3	Drill	3	20
		4	Inspect	4	0.2
		5	Unload	1	2

Determine:

a) the maximum production rate of the FMS [12]

b) the corresponding production rate of each part [4]

c) the utilisation of each station in the system [4]

Question 3

An existing Flexible Manufacturing System (FMS) has 20 hours per week of unused capacity. Six part types are being considered for FMS production. The Horizontal Machining Center (HMC) is the most limited resource on the FMS. The current purchase price, annual demand and production time on the HMC for each part are shown in Table Q3 below. If the parts are produced on the FMS, the unit cost of each part type is expected to reduce by 13%.

Table Q3: Part Type Data for Question 3

Part	**1**	**2**	**3**	**4**	**5**	**6**
Unit purchase price ($)	50	120	87	66	138	99
Annual demand rate (units)	100	300	1000	500	500	250
Production time per unit (hrs)	3.0	1.2	2.3	1.1	1.4	2.0

a) Suppose the FMS is to be fully utilised. Parts may be produced partially in-house and the remaining units purchased. Which parts should be added to the FMS? [10]
b) Suppose parts must either have all units purchased or made on the FMS. Which parts should be added to the FMS? [6]
c) Determine the cost savings in both cases and suggest the best way forward. [4]

SECTION B: MATERIAL HANDLING

Question 4

a) TR & C Engineering Solutions has a unit load Automated Storage and Retrieval System (AS/RS) with six aisles. Six Storage and Retrieval (S/R) machines are used, one for each aisle. The aisle length (rack length) is 275 m and the aisle height is 77.5 m. the horizontal and vertical speeds are 300 m/min and 70 m/min respectively. The pick and drop (P/D) operation of the S/R machine takes approximately 0.35 min. Determine the single and dual command cycle times for the unit load AS/RS. [12]

b) Briefly describe any two types of Automated Guided Vehicle Systems (AGVS). [8]

Question 5

a) Using appropriate examples of their application, distinguish clearly between gravity conveyors and powered conveyors. [8]
b) Discuss, citing examples, how material handling can be used to improve productivity in a company of your choice. [12]

Question 6

a) Batches of parts arrive at a warehouse for storage. The number of pallet loads in the batch has mean 5 and variance 4. Batches arrive at a rate of 10 per day. A single stacker is available for storing loads. The average time to store is exponentially distributed with mean 0.01 days. Calculate the expected number of loads waiting to be stored. [5]

b) A 100 m long conveyor has carriers spaced every 10 m. parts arrive at a rate of 2 per minute to be loaded. Actual loading takes very little time. Find the minimum conveyor speed to prevent blocking of incoming arrivals due to unavailability of a carrier. [3]

c) Explain why the cheapest material handling system capable of moving material between locations may not be the best system. [4]

d) Describe any two basic types of material handling equipment. For each of your chosen type, describe the environment where usage is appropriate. [8]

Question 7

a) Using appropriate examples to aid your answer, distinguish clearly between the two categories of load transfer operations of Automated Guided Vehicle Systems (AGVS). [12]

b) A company is planning to integrate the Automated Guided Vehicle System (AGVS) and Automated Storage and Retrieval System (AS/RS) with their Flexible Manufacturing System (FMS). The AGVS must be capable of making 51 deliveries per hour. The company has already decided to install a laser guide path system and the unit load AGVS adequately serves the company's needs. The following data has been collected:

Vehicle speed	=	180 m/min
Average loaded travel distance per delivery	=	540 m
Average empty travel distance per delivery	=	300 m
Pick-up time	=	0.5 min
Drop-off time	=	0.5 min
Traffic factor	=	0.85

Determine the number of vehicles required to satisfy the needs of the manufacturing system. [8]

END OF EXAMINATION