BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
First Semester 2022-23
Flexible Manufacturing Systems (BITS F431)
Comprehensive Examination (Closed Book)
Date: 26-12-2022

Maximum Time: 180 min. **Maximum Marks: 40**

Note: Be succinct, no credit will be given for ambiguous and partially correct answers. All parts of a question must be answered together and in sequence.

Q1. Answer the following questions **briefly.**

i) How do you define the word "flexibility" in a Flexible Manufacturing System? [2]
ii) Why are continuous work transport systems uncommon on automated production lines? [2]
iii) How is machine cluster different from machine cell? [2]
iv) How do you measure the errors in AIDC? [2]
v) What is forward sensing in AGVS terminology? [2]

Q2. Answer the following questions **with proper sketch.**

i) Direction of workflow in FMS ladder layout. [2]
ii) Typical torque-speed curve of a stepper motor. [2]
iii) Levels of automation and control in manufacturing. [2]
iv) Feedforward control. [2]
v) Work transport with variable routing. [2]

Q3.

a) A 22-station in-line transfer machine has an ideal cycle time of 0.58 min. Station breakdowns occur with a probability of 0.01. Assume that station breakdowns are the only reason for line stops. Average downtime is 8.0 min per line stop. Determine (a) ideal production rate, (b) frequency of line stops, (c) average actual production rate, and (d) line efficiency. [6]

b) The CNC grinding section has a large number of machines devoted to grinding shafts for the automotive industry. The grinding machine cycle takes 3.6 min. At the end of this cycle an operator must be present to unload and load parts, which takes 40 sec. (a) Determine how many grinding machines the worker can service if it takes 20 sec to walk between the machines and no machine idle time is allowed. (b) How many seconds during the work cycle is the worker idle? (c) What is the hourly production rate of this machine cluster? [4]

Q4.

A manual assembly line operates with a mechanized conveyor. The conveyor moves at a speed of 5 ft/min, and the spacing between base parts launched onto the line is 4 ft. It is determined that the line operates best when there is one worker per station and each station is 6 ft long. There are 14 work elements that must be accomplished to complete the assembly, and the element times and precedence requirements are listed in the table below. Determine (a) Feed rate and corresponding cycle time, (b) Tolerance time for each worker, and (c) Ideal minimum number of workers on the line. (d) Draw the precedence diagram for the problem. (e) Use the largest candidate rule to assign work elements to stations. (f) Compute the balance delay for your solution. Assume any other parameter if required. [10]

Element	$T_e(min)$	Preceded By	Element	$T_e(min)$	Preceded By
1	0.2	-	8	0.2	5
2	0.5	-	9	0.4	5
3	0.2	1	10	0.3	6,7
4	0.6	1	11	0.1	9
5	0.1	2	12	0.2	8,10
6	0.2	3,4	13	0.1	11
7	0.3	4	14	0.3	12,13

**********Best of luck**********