

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-I B. Sc. Engineering Examinations 2023-2024

Sub: **IPE 419** (Computer Integrated Manufacturing)

Full Marks: 210

Time: 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

**SECTION – A**There are **FOUR** questions in this section. **Question No. 1 is mandatory.**Answer any **TWO** from the remaining **THREE** questions.

1. (a) What do you understand by a production system. Using a block diagram, briefly explain facilities and manufacturing support system of a production system. (5×7=35)
- (b) Briefly discuss the reasons for automation and computer-integrated manufacturing.
- (c) Explain the qualities that make industrial robots commercially and technologically important.
- (d) For discrete process control, discuss similarities and dis-similarities between logic control, and sequence control with appropriate examples.
- (e) How does Computer Aided Process Planning (CAPP) system help the manufacturing engineers? Discuss in short.
- (f) What is the difference between rapid prototyping and virtual prototyping?
- (g) What are the tests that qualify a manufacturing system as flexible? Briefly explain.
  
2. (a) Nearly all industrial robots have mechanical joints that can be classified into one of five types. What are those types? Explain with necessary sketches. (8)
- (b) Draw a typical configuration of a three-axis wrist assembly showing roll, pitch, and yaw. Discuss different sensors used in industrial robots. (12)
- (c) A push-button switch used for starting and stopping electric motors and other powered devices is a common hardware component in industrial control systems. It consists of a box with two buttons, one for START and the other for STOP. When the START button is depressed momentarily by a human operator, power is supplied and maintained to the motor (or other load) until the STOP button is pressed momentarily, which breaks the power to the POWER-TO-MOTOR. POWRE-TO-MOTIOR is the output of the push-button switch, but it also serves as a contact to power the motor.
- (i) Define the initial values of the variables. Construct (ii) the truth table for the push button and (iii) the logic network diagram and (iv) ladder logic diagram. (15)

Contd ..... P/2

**IPE 419**

3. (a) An automated manufacturing system, consider a machine cell consisting of two CNC machine tools that are loaded and unloaded by an industrial robot from a parts storage system. Draw schematic diagram of the system. It is a flexible cell? Explain why. (10)
- (b) What are three basic components of a flexible manufacturing system? In addition, even though an FMS is highly automated, people are required to manage and operate the system. What are the functions typically performed by humans. Discuss in short. (10)
- (c) CIM is sometimes spoken of interchangeably with CAM and CAD/CAM. Although the terms are closely related, CIM has a broader meaning than CAM or CAD/CAM. Explain how. (15)
4. (a) Make a list of the many decisions and details usually included within the scope of process planning. With necessary diagram, discuss typical sequence of processes required in part fabrication. (15)
- (b) Discuss any system that will collect and store production process related information using embedded system connected sensors, make intelligent decisions based on historical sensor data stored in servers and actuate any device that will control the production process if the process goes out of its prescribed ranges. (20)

**SECTION – B**

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) The from-to chart below indicates the number of loads moved per 8-hour day (above the slash) and the distances in feet (below the slash) between departments in a particular factory. Forklift trucks are used to transport the materials. They move at an average speed of: (25)
- 275 ft/min (loaded)  
350 ft/min (empty)
- Load handling time (loading plus unloading) per delivery is 1.5 minutes, and the anticipated traffic factor is 0.9. Availability = 95%, Worker efficiency = 110%. Determine the number of trucks required under each of the following assumptions:
- The trucks never travel empty.
  - The trucks travel empty a distance equal to their loaded distance.

From Dept.	To Dept. A	To Dept. B	To Dept. C	To Dept. D	To Dept. E
A	0 / 0	62 / 500	51 / 450	45 / 350	---
B	---	0 / 0	22 / 400	---	---
C	---	---	0 / 0	---	76 / 200
D	---	---	---	0 / 0	65 / 150
E	---	---	---	---	0 / 0

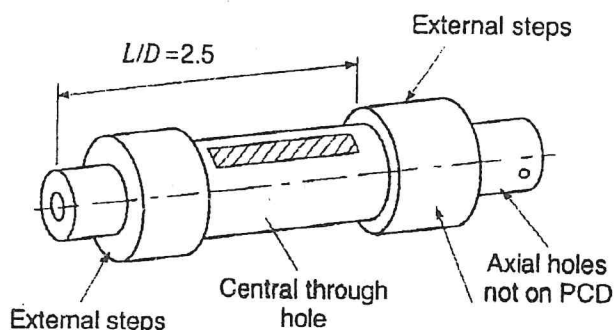
Contd ..... P/3

**IPE 419**

**Contd ... Q. No. 5**

(b) You are provided with a rotational part.

(10)



Using the Opitz system, determine the first five digits of the form code for this part.

6. (a) An AS/RS with four aisles is 80 meters long and 18 meters high. The S/R machine has a maximum horizontal speed of 1.6 m/sec. It accelerates from 0 to 1.6 m/sec in a distance of 2.0 m, and decelerates from 1.6 m/sec to 0 over the same distance of 2.0 m. The maximum vertical speed is 0.5 m/sec, with acceleration and deceleration distances of 0.3 m each.

(20)

Acceleration and deceleration rates are constant in both directions.

Pick-and-deposit time = 12 seconds

Utilization of AS/RS = 90%

The number of dual-command cycles = the number of single-command cycles

(i) Calculate the single-command and dual-command cycle times, including considerations for acceleration and deceleration.

(ii) Determine the throughput rate for the system.

- (b) Compare and contrast the Token Passing, CSMA/CD, and ATM access control methods with respect to:

(15)

- Latency under low and high loads
- Collision risk
- Bandwidth utilization
- Suitability for real-time control systems

Which method is most suitable for automated shop floors, and why might token passing still be used despite higher latency in light loads?

Contd ..... P/4

**IPE 419**

7. (a) Compare and contrast bar code systems and radio frequency identification (RFID). In what types of industrial or supply chain scenarios would the adoption of RFID be more justifiable despite its higher initial cost? Justify your reasoning with technical and economic arguments. (10)

(b) A group-technology cell consists of four machines and processes a family of six part styles in equal quantities. During an 8-hour shift, a total of 180 parts are produced, and each part spends 32 minutes in the cell on average, either being processed or waiting. All six part styles go through all four machines in the same order. (25)

One machine is the key machine, utilized at 100%. The other three machines have utilizations ranging between 60% and 85%. Five parts in the family require no changeover time on any machine, but the six<sup>th</sup> part requires a 4-minute changeover time on the key machine. These six parts are currently produced consecutively, causing a disproportionate amount of time on the key machine to be spent processing the six<sup>th</sup> part.

(i) What is the average work-in-progress (WIP) in the cell at any moment?

(ii) A proposal has been made to process the six<sup>th</sup> part in batches, so the 4-minute changeover time would be spread over the number of units in the batch.

(iii) How many hours would be required to process the same 180 parts if the six<sup>th</sup> part was processed in batch sizes of 10 parts?

8. (a) Describe a real-life industrial network scenario (e.g., remote robot control, CNC program upload) and map each of the 7 OSI layers to a specific function or component involved in that communication. (15)

(i) Why is separating these layers essential for diagnosing issues?

(ii) How does each layer contribute to data integrity and communication success?

(b) With the rise of Cyber-Physical Production Systems (CPPS), the line between cyber security and physical safety blurring. (20)

(i) Define and distinguish between security and safety in the context of FoF.

(ii) Analyze how interconnected systems can introduce new emergent risks, and propose strategic to mitigate them using IEC 62443 or similar frameworks.

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