DHANALAKSHMI COLLEGE OF ENGINEERING

ME6703 COMPUTER INTEGRATED MANUFACTURING SYSTEMS

UNIT-I INTRODUCTION

1. Define – CAD and CAM

CAD may be defined as any design activity that involves the effective use if computer to create, modify or document engineering design.

CAM may be defined as an effective use of computers and computer technology in the planning, management and control of the manufacturing function.

2. List out the fundamental reason for implementing a CAD system.

Reasons for implementing a CAD system are

a. Identify productive activities.
b. Develop an implementation plan.
c. Establish good practices.
d. Plan your system architecture.

3. Define – CIM

Computer Integrated Manufacturing (CIM) denotes the pervasive use of computer system to design the products, plan the production, control the operations, and perform the various information-processing functions needed in a manufacturing firm.

CIM = CAD + CAM + Business function

4. Write the types of production

a. continuous production

The process is carried out on a continuous stream of material, with no interruptions in the output flow.

b. batch production

batch production is discontinuous because there are interruptions in production between batches.

5. What is lean production?

Lean production means operating the factory with the minimum possible resources and yet maximizing the amount of work that is accomplished with these resources.

6. Define – Production Capacity

Production capacity is defined as the maximum rate of output that a production facility is able to produce under a given set of assumed operating conditions.

7. Define – Utilization and Availability

Utilization refers to the amount of output of a production facility relative to its capacity.

$Utilization, U = \frac{Q}{PC}$

Where, Q = actual quantity produced by the facility during a given period of time
PC = production capacity for the same period

Availability is defined using two other reliability terms, mean time between failures (MTTF) and mean time to repair (MTTR).

$$Availability = \frac{MTBF - MTTR}{MTBF}$$

8. Define – Manufacturing Lead Time

The total time required to process a given part of product through the plant, including any lost time due to delays; time spent in storage, reliability problems and so on.

9. Define – Direct Labor, Material and Overhead Cost

Direct labor cost is the sum of wages and benefits paid to the workers who operate the production equipment and perform the processing and assembly tasks.

Material cost is the cost of all raw materials used to make the product.

Overhead costs are all of the other expenses associated with running the manufacturing firm.

10. Define – Fixed Cost and Variable Cost

A fixed cost is one that remains constant for any level of production output.
(Example) the cost of the factory building and production equipment, insurance and property taxes.

A variable cost is one that varies in proportion to the level of production output.
(Example) direct labor, raw materials and electric power to operate the production equipment.

11. Name five typical factory overhead expenses

1. Insurance
2. Factory and equipment depreciation
3. Applicable taxes
4. Power
5. Maintenance crew

12. Name five typical corporate overhead expenses

1. Corporate executives
2. Sales and marketing
3. Finance department
4. Security personnel
5. Research and development

13. Define – Automation

Automation can be defined as the technology by which a process or procedure is accomplished without human assistance. It is implemented using a program of instructions combined with a control system that executes the instructions.

14. Write the basic elements of an automated system.

An automated system consists of three basic elements:

1. Power
2. Program of instructions
3. Control system

15. Differentiate open loop and closed loop control system in an automation system.

An open loop control system operates without the feedback loop. In this case, the controls operate without measuring the output variable, so no comparison is made between the actual value of the output and the desired input parameter.

A closed loop control system is one in which the output variable is compared with an input parameter, and any difference between the two is used to drive the output into agreement with the input.

16. Identify the five levels of automation in a production plant.

1. Device level
2. Machine level
3. Cell or system level
4. Plant level
5. Enterprise level

17. What is the role of CIM in manufacturing?

CIM is most closely associated with functions in manufacturing engineering such a process planning and numerical control (NC) part programming.

18. What are important applications of CIM in manufacturing planning?

The applications of CIM can be divided into two broad categories.

a. Manufacturing planning b. Manufacturing control

UNIT-II PRODUCTION PLANNING AND CONTROL AND COMPUTERISED PROCESS PLANNING

1. Define – Process Planning

Process planning involves determining the sequence of processing and assembly steps that must be accomplished to make the product.

2. Define – Route Sheet

The processing sequence is documented on a form called a route sheet or operation sheet.

3. Define – Concurrent Engineering

Concurrent Engineering is an approach used in product development in which the functions of design engineering, manufacturing engineering and other functions are integrated to reduce the elapsed time required to bring a new product to market.

4. Write the benefits of CAPP.

1. Process rationalization and standardization
2. Increased productivity of process planners
3. Reduced lead time for process planning
4. Improved legibility
5. Incorporation of other application programs

5. Write the types of process planning.

1. Manual process planning
2. Computer Aided Process Planning
   (a) Retrieval CAPP systems
   (b) Generative CAPP systems

6. What is meant by retrieval CAPP systems?

A retrieval CAPP system, also called a variant CAPP system, is based on the principles of GT and parts classification and coding. A standard process plan is stored in computer files for each part family. Developing the database of these process plan requires substantial effort.

7. What is meant by generative CAPP systems?

The process sequence is planned without human assistance and without a set of predefined standard plans.

8. Define – Production Planning and Control

PPC is concerned with the logistics problems that are encountered in manufacturing, that is, managing the details of what and how many products to produce and when, and obtaining the raw materials, parts and resources to produce those products.

9. What are the activities within the scope of production planning?

1. Aggregate production planning

2. Master Production Schedule (MPS)
3. Material Requirement Planning (MRP)
4. Capacity Planning (CP)

10. What is the difference between the aggregate production planning and master production schedule?

Aggregate production planning involves planning the production output levels for major product lines produced by the firm. Aggregate planning involves planning six months or more into the future.

MPS which is a specific plan of the quantities to be produced of individual models within each product line. MPS is concerned with shorter term.

11. What is meant by MRP?

MRP is a planning technique that converts the master schedule for end products into a detailed schedule for the raw materials and components used in the end products.

12. What are the main inputs to the MRP processor?

1. Master production schedule
2. Bill of materials
3. Inventory record file

13. What are the outputs to the MRP system?

1. Planned order release
2. Reports of planned order release in future periods
3. Rescheduling notices, indicating changes in due dates for open orders
4. Reports on inventory status
5. Exception reports
6. Performance reports

14. Write the benefits of MRP system.

1. reduction in inventory
2. quicker response to changes in demand
3. reduced setup and product changeover costs
4. better machine utilization
5. improved capacity to respond to changes in the master schedule

15. What is meant by capacity planning? And write the two stages of capacity planning.

Capacity planning consists of determining what labor and equipment resources are required to meet the current MPS as well as long-term future production needs of the firm.

Stages of Capacity planning:

(a) rough cut capacity planning (RCCP)

(b) Capacity requirements planning (CRP)

16. Define – Shop Floor Control

SFC is the set of activities in production control that is concerned with releasing production orders to the factory, monitoring and controlling the progress of the orders through the various work centers, and acquiring current information on the status of the orders.

17. Write the three phases of shop floor control.

1. Order release
2. Order scheduling
3. Order progress

18. Define – Shop Packet

The collection of documents through the factory called shop packet. It consists of

1. the route sheet
2. material requisitions to draw the raw materials from inventory
3. job cards means to report direct labor time devoted to the order
4. move tickets to authorize the material handling personnel to transport parts between work centers
5. the part list

19. Define –Factory Data Collection System

The FDC system consists of the various paper documents, terminals and automated devices located throughout the plant for collecting data on shop floor operations

20. Define – MRP II

Management Resource Planning (MRP II) can be defined as a computer based system for planning, scheduling and controlling the materials, resources and supporting activities needed to meet the master production schedule.

21. Define – ERP

Enterprise Resource Planning (ERP) is a computer software system that organizes and integrates all of the data and business functions of an organization through a single, central data base.

UNIT-III CELLULAR MANUFACTURING

1. Define – Group Technology

Group Technology [GT] is a manufacturing methodology in which identical or similar components grouped processed together during design, process planning and manufacturing so that a wide variety of components can be manufactured, at the least expense of time, inventory, man hours and material handling.

2. List out the stages in Group Technology.

The stages in Group Technology are

a] Production planners to setup the GT database.

b] Grouping the parts or components into part-families with some similar characteristics.

c] Re-design the shop-floor arrangement according to common shape, function or manufacturing process and tooling.

3. Define – Part Family

Part family is defined as collection of parts which are similar either in geometric shape and size or in the processing steps required in their manufacture.

4. What are the three methods for solving the problem of grouping parts into part families?

1. Visual inspection
2. Parts classification and coding system
3. Production flow analysis

5. What is the difference between a hierarchical structure and a chain type structure in a classification and coding scheme?

Hierarchical structure, also known as monocode, in which the interpretation of each successive symbol depends on the value of the preceding symbols.

Chain type structure, also known as polycode, in which the interpretation of each symbol in the sequence is always the same; it does not depend on the value of preceding symbols.

6. Write the benefits of GT.

1. GT promotes standardization of tooling, fixturing and setups
2. Material handling is reduced
3. Process planning and production scheduling are simplified
4. Setup times are reduced, resulting in lower manufacturing lead times
5. Work-in-progress is reduced

7. Define – Production Flow Analysis (PFA)

Production flow analysis is a technique for pre-planning the division of the whole factory into groups or departmental groups. When the knowledge of division is available, then it is possible to plan the layout.

8. What is the weakness of PFA?

The weakness of production flow analysis (PFA) is that the data used in the technique are derived from existing production route-sheets. But the process-sequences have been prepared by different process planners and the difference is reflected on to these route-sheets.

10. Write the steps involved in production flow analysis.

1. Data collection
2. Sortation of process routings
3. PFA chart
4. Cluster analysis

11. Define – Cellular Manufacturing

Cellular manufacturing is an application of GT in which dissimilar machines or processes have been aggregated into cells, each of which is dedicated to the production of a part.

12. Explain the two categories of attributes of parts.

1. Design attributes, which are concerned with part characteristics such as geometry, size, length-to-diameter ratio, surface finish and tolerances.
2. Manufacturing attributes, which consider the sequence of processing steps required to make a part, machine tool, batch size, annual production and cutting tools.

13. Write the applications of GT.

1. Manufacturing applications
    (a) Informed scheduling and routing of similar parts through selected machines
    (b) Virtual machine cells
    (c) Formal machine cells
2. Product design applications

14. What is meant by composite part concept?

The composite part concept takes this part family definition to its logical conclusion. The composite part for a given part family is a hypothetical part that includes all of the design and manufacturing attributes of the family.

15. Write the types of machine cells and layouts in GT.

1. Single machine cell
2. Group machine cell with manual handling
3. Group machine cell with semi-integrated handling
4. Flexible manufacturing cell

16. Write the various types of coding system.

1. OPITZ
2. MICLASS
3. DCLASS

UNIT-IV FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDED VEHICLE SYSTEM (AGVS)

1. Define – FMS

A Flexible Manufacturing System [FMS] is a highly automated GT machine cell, consisting of a group of processing workstations, interconnected by an automated material handling and storage system, and controlled by a distributed computer system

2. What are the components of FMS?

Flexible Manufacturing Systems [FMS] consists of the following four components.

1. Processing stations or workstations
2. Material handling and storage
3. Computer control system
4. Human labor

3. What are the objectives of FMS?

The Objectives of FMS are

1. To provide flexible manufacturing facility for pan family components.
2. To provide the benefits of grouping the operation in single location.
3. To provide the flexibility in producing small and medium parts.
4. To maximize the utilization of facilities.
5. To have a good management control.

4. What are the types of layout configuration in FMS?

FMS can be divided into five categories

1. In-line layout
2. Loop layout
3. Ladder layout
4. Open field layout
5. Robot-centered cell.

5. What is the difference between a dedicated FMS and a random-order FMS?

A dedicated FMS is designed to produce a limited variety of part styles, and the complete universe of parts to be made on the system is known in advance.

A random-order FMS is more appropriate when the part family is large, there are substantial variations in part configurations, new part designs will be introduced into the system and engineering changes will occur in parts currently produced, and the production schedule is subject to change from day to day.

6. List out any two advantages and disadvantages of FMS implementation.

Advantages of FMS implementation.

1. Faster
2. Lower-cost changes from one part to another which will improve capital utilization

Disadvantages of FMS implementation.

1. 1ower direct labor cost
2. Due to the reduction in number of workers

7. How the FMS is classified based on level of flexibility?

FMS classified based on level of flexibility are

1. Production flexibility
2. Machine flexibility
3. Mix flexibility
4. Product flexibility

8. How the FMS is classified based on number of machines?

The FMS is classified based on number of machines are

1. Single Machine Cell (SMC)
2. Flexible Manufacturing Cell (FMC)
3. Flexible Manufacturing System (FMS)

9. What are the types of FMS?

The types of FMS are

1. Dedicated FMS
2. Engineered FMS
3. Random order FMS

10. What is FMS?

FMS is a manufacturing system based on multi-operation machine tools, incorporating (automatic part handling and storage).

11. Write the FMS benefits.

1. Increased machine utilization
2. Fewer machines required
3. Reduction in the amount of factory floor space required
4. Reduced inventory requirements
5. Lower manufacturing lead times
6. Greater responsiveness to change

12. Define – AGVS

An Automated Guided Vehicle system is a material handling system that uses independently operated, self-propelled vehicles guided along defined pathways.

13. What are the components of AGVS?

1. The vehicle
2. Guide path
3. Control unit
4. Computer interface

14. Write the types of AGVS.

1. Driverless trains

A driveless train consists of a towing vehicle pulling one or more trailers to forma train. A common application is moving heavy payloads over long distances in warehouses or factories with or without intermediate pickup and drop-off points along the route.

2. Unit load carriers

AGV unit load carriers are used to move unit loads from one station to another. They are often equipped for automatic loading and unloading of pallets by means of powered rollers, moving belt, mechanized lift platforms built into the vehicle deck.

3. Pallet trucks

AG pallet trucks, are used to move palletized loads along predetermined routes.

15. Write the AGVS applications.

1. driveless train operations
2. storage and distribution
3. assembly line applications
4. flexible manufacturing systems

16. What is meant by vehicle guidance technology?

The guidance system is the method by which AGVS pathways are defined and vehicles are controlled to follow the pathways.

17. Name the different AGVS guidance system.

1. imbedded guide wires
    a. frequency select method
    b. path switch select method
2. paint strips
3. self-guided vehicles

18. What is the purpose of traffic control in AGV system?

The purpose of traffic control in an automated guided vehicle system is to minimize interference between vehicles and to prevent collisions.

19. Write the types of methods of traffic control in AGV system.

1. On-board vehicle sensing

On-board vehicle sensing, also called *forward sensing*, uses one or more sensors on each vehicle to detect the presence of other vehicles and obstacles ahead on the guide path. When the on-board sensor detects an obstacle in front of it, the vehicle stops.

2. Zone control

In zone control, the AGVS layout is divided into separate zones, and the operating rule is that no vehicle is permitted to enter a zone that is already occupied by another vehicle.

UNIT-V INDUSTRIAL ROBOTICS

1. Define – Robot

Robot is a programmable, multifunction manipulator designed to move materials, parts, tools or special devices through variable programmed motions for the performance of the variety of tasks.

2. Write the types of joint notations.

1. Linear joint (type L joint), the relative movement between the input link and the output link is a translational sliding motion, with the axes of the two links parallel.

2. Orthogonal joint (type O joint), this is also a translational sliding motion, but the input and output links are perpendicular to each other during the move.

3. Rotational joint (type R joint), it provides rotational relative motion, with the axis of rotation perpendicular to the axes of the input and output links.

4. Twisting joint (type T joint), involves rotary motion, but the axis of rotation is parallel to the axes of the two links.

5. Revolving joint (type R joint) the axis of the input link is parallel to the axis of rotation of the joint, and the axis of the output link is perpendicular to the axis of rotation.

3. What are the four basic robot configurations available commercially?

1. Cartesian coordinate robot
2. Cylindrical configuration
3. Polar configuration
4. Jointed arm robot
5. SCARA

4. What is meant by Work space?

The space in which the end point of the robot arm is capable of operating is called as workspace in other words reach ability of robot arm is known as workspace.

5. Define – Work Volume

The work volume of the manipulator is defined as the envelope or 3D space within which the robot can manipulate the end of its wrist.

6. What is an end effector?

The end effector enables the robot to accomplish a specific task. The two categories of end effectors are (a) grippers and (b) tools

7. Define – Grippers

Grippers are end effectors used to grasp and manipulate objects during the work cycle.

Types of grippers:

1. Mechanical grippers
2. Vacuum grippers

3. Magnetic devices
4. Adhesive devices

8. Classify the sensors in robotics

Sensors used in industrial robotics can be classified into two categories:

1. *Internal sensors* are components of the robot and are used to control the position and velocities of the various joints of the robot. These sensors form a feedback control loop with the robot controller.

2. *External sensors* are used to coordinate the operation of the robot with the other equipment in the cell.

9. Name the various sensors used in industrial robotics

1. Tactile sensors
2. Proximity sensors
3. Optical sensors
4. Machine vision

10. Define – Control Resolution, Accuracy and Repeatability of Robot

Control resolution refers to the capability of the robot's positioning system to divide the range of the joint into closely spaced points, called addressable points, to which the joint can be moved by the controller.

$$Control\ resolution, CR = \frac{R}{2^B - 1}$$

Accuracy is the robot's ability to position the end of its wrist at a desired location in the work volume.

$$Accuracy = \frac{CR}{2} + 3\sigma$$

Repeatability is a measure of the robot's ability to position its end-of-wrist at a previously taught point in the work volume.

$$Repeatability = \pm 3\sigma$$

11. What is meant by pitch, yaw and roll?

Pitch is rotation around the X-axis, Yaw is around the Y-axis, and roll is around the Z-axis.

12. Write the applications of an industrial robot.

1. Repetitive work cycle
2. Material handling
    a. Material transfer
    b. Machine loading and unloading
3. Processing operations
    a. Spot welding
    b. Arc welding

c. Spray coating

4. Assembly and inspection

13. Define – Robot Programming

A robot programming can be defined as a path in space to be followed by the manipulator, combined with peripheral actions that support the work cycle.

14. Write the types of robot programming methods.

1. Leadthrough programming
2. Computer-like robot programming languages
3. Off-line programming