Version A

Scoring Indicators

COURSE NAME: REV (21)-6021B– COMPUTER INTEGRATED MANUFACTURING

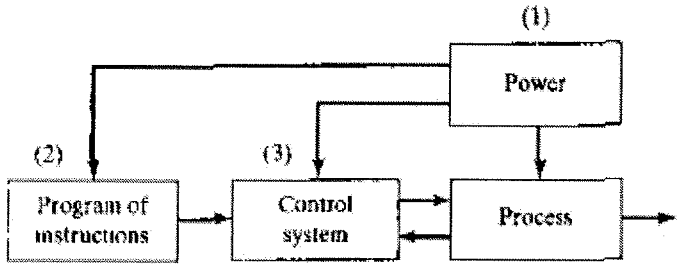
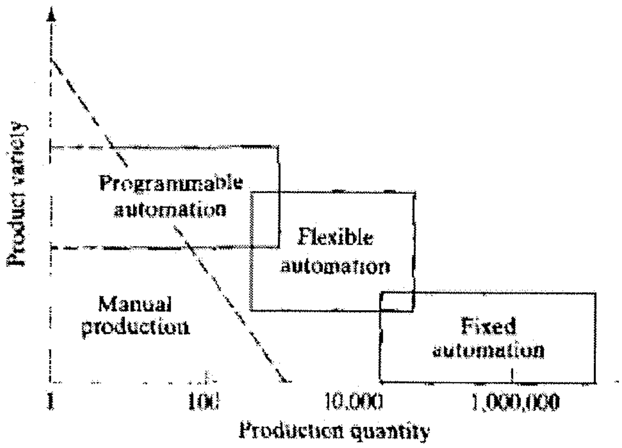
COURSE CODE: 6021B **QID:** 2102240023

Q No	Scoring Indicators	Split score	Sub Total	Total score
	PART A			**9**
I. 1	Actuator is a hardware device that converts a controller command signal into a change in a physical parameter.		1	
I. 2	Facilities and Manufacturing support systems		1	
I. 3	Recalibration		1	
I. 4	Finite Element Analysis		1	
I. 5	Stereo lithography, Selective Laser Sintering		1	
I. 6	Master production schedule		1	
I. 7	Processing sequence of operations of a product documented on a form		1	
I. 8	unit load is simply the mass that is to be moved or otherwise handled at one time.		1	
I. 9	Co ordinate Measuring machine		1	
	PART B			24
II. 1	**Accelerometer** Analog device used to measure vibration and shock. Can be based on various physical phenomena. **Ammeter** Analog device that measures the strength of an electrical current. **Bimetallic switch** Binary switch that uses bimetallic coil to open and close electrical contact as a result of temperature change. Bimetallic coil consists of two metal strips of different thermal expansion coefficients bonded together. **Bimetallic thermometer** Analog temperature measuring device consisting of bimetallic coil (see definition above) that changes shape in response to temperature change. Shape change of coil can be calibrated to indicate temperature. **DC tachometer** Analog device consisting of dc generator that produces electrical voltage proportional to rotational speed **Dynamometer** Analog device used to measure force. Power or torque.	1x3	3	
II. 2	The USA Principle is a common sense approach to automation projects. Similar procedures have been suggested in the manufacturing and automation trade literature, but none has a more captivating title than this one. USA stands for 1. Understand the existing process 2. Simplify the process 3. Automate the process. **Understand the Existing Process**. The obvious purpose of the first step in the USA approach is to comprehend the current process in all of its details. What are the inputs? What are the outputs? What exactly happens to the work unit between input and output? What is the function of the process? How does it add value to the product? What are the upstream and downstream operations in the production sequence, and can they be combined with the process under consideration? **Simplify the Process**. Once the existing process is understood, then the search can begin for ways to simplify. This often involves a checklist of Questions about the existing process. What is the purpose of this step or	1x3	3	

	this transport? Is this step necessary? Can this step be eliminated? Is the most appropriate technology being used in this step? How can this step be simplified? Are there. Unnecessary steps in the process that might be eliminated without detracting from function? **Automate the Process.** Once the process has been reduced to its simplest form, then automation can be considered.			
II. 3	1. To increase labour productivity 2. To reduce Labour cost 3. To mitigate the effects of Labour shortages 4. To improve Worker safety.	1x3	3	
II. 4	**Mass properties analysis**, which involves the computation of such features of a solid object as its volume, surface area, weight, and center of gravity. It is especially applicable in mechanical design. Prior to CAD, determination of these properties often required painstaking and time-consuming calculations by the designer. **Interference checking.** This CAD software examines 2-D geometric models consisting of multiple components to identify interferences between the components. It is useful in analyzing mechanical assemblies, chemical plants, and similar multicomponent designs **Tolerance analysis.** Software for analyzing the specified tolerances of products components is used for the following functions: (1) to assess how the tolerances may affect the product's function and performance, (2) to determine how tolerances may influence the ease or difficulty of assembling the product. and (3) to assess how variations in component dimensions may affect the overall size of the assembly. **Finite element analysis.** Software for finite element analysis (FEA), also known as finite element modeling (FEM). is available for use on CAD systems to aid in stressstrain, heat transfer, fluid flow, and other engineering computations, Finite element analysis is a numerical analysis technique for determining approximate solutions to physical problems described by differential equations that are very difficult or impossible to solve. In FEA. the physical object is modeled by an assemblage of discrete interconnected nodes (finite elements), and the variable of interest (e.g., stress, strain, temperature) in each node can be described by relatively simple mathematical equations **Kinematic and dynamic analysis.** Kinematic analysis involves the study of the operation of mechanical linkages to analyze their motions. A typical kinematic analysis consists of specifying the motion of one or more driving members of the subject linkage, and the resulting motions of the other links are determined by the analysis package. Dynamic analysis extends kinematic analysts by including the effects of the mass of each linkage member and the resulting acceleration forces as well as any externally applied forces **Discrete-event simulation.** This type of simulation is used to model complex operational systems, such as a manufacturing cell or a material handling system, as events occur at discrete moments in time and affect the status and performance of the system. For example, discrete events in the operation of a manufacturing cell include parts arriving for processing or a machine breakdown in the cell. Measures of the status and performance include whether a given machine in the cell is idle or busy and the overall production rate of the cell.	1x3	3	
II. 5	Geometric modeling involves the use of a CAD system to develop a mathematical description of the geometry of an object. The mathematical description, called a geometric model, is contained in computer memory. This permits the user of the CAD system to display an image of the model on a graphics terminal and to perform certain operations on the		3	

	model. These operations include creating new geometric models from basic building blocks available in the system, moving the images around on the screen, zooming in on certain features of the image, and so forth. These capabilities permit the designer to construct a model of a new product (or Its components) or to modify an existing modelling			
II. 6	• GT promotes standardization of tooling, fixturing. and setups. • Material handling is reduced because parts are moved within a machine cell rather than within the entire factory. • Process planning and production scheduling are simplified • Setup times are reduced, resulting in lower manufacturing lead times. • Work-in-process is reduced. • Worker satisfaction usually improves when workers collaborate in a GT cell. • Higher quality work is accomplished using group technology	½ x 6	3	
II. 7	Material Handling Processing operations Assembly and inspection	1x3	3	
II. 8	• New equipment Investments. • New plant construction. • Purchase of existing plants from other companies •Acquisition of existing companies. • Plant closings	1x3	3	
II.9	Automated guided vehicles (AGVs), AGVs are battery-powered, automatically steered vehicles that follow defined pathways in the floor. The pathways are unobtrusive. AGVs are used to move unit loads between load and unload stations in the facility. Routing variations arc possible, meaning that different loads move between different stations. They are usually interfaced with other systems to achieve the full benefits of integrated automation		3	

II.10	Machine vision can be defined as the acquisition of image data, followed by the processing and interpretation of these data by computer for some useful application. Machine vision (also called computer vision, since a digital computer is required to process the image data) is a rapidly growing technology, with its principal applications in industrial inspection. In Ihis section, we examine how machine vision works and its applications in QC inspection and other areas. Vision systems are classified as being either 2-D or 3-D. Two-dimensional systems view the scene as a 2-D image. This is quite adequate for most industrial applications, since many situations involve a 2-D scene, Examples include dimensional measuring and gauging, verifying the presence of components. And checking for features on a Flat (or semi flat) surface. Other applications require 3-D analysis of the scene, and 3-D vision systems are required for this purpose.		3	
	PART C			42

III. 1	An automated system consists of three basic elements: (1) power to accomplish the process and operate the system. (2) a program of instructions to direct the process, and (3) a control system to actuate the Instructions.  	Fig.2 Exp.5	7	7
III. 2	The relative positions of the three types of automation for different production volumes and product varieties are depicted in Figure.  **Fixed Automation**. Fixed automation is a system in which the sequence of processing (or assembly) operations is fixed by the equipment configuration. Each of the operations in the sequence is usually simple, involving perhaps a plain linear or rotational motion or an uncomplicated combination of the two; for example, the feeding of a rotating spindle. It is the integration and coordination of many such operations into one piece of equipment that makes the system complex. Typical features of fixed automation are: • high initial investment for custom-engineered equipment • high production rates • relatively inflexible in accommodating product variety **Programmable Automation**. In programmable automation. the production equipment is designed with the capability to change the sequence of operations to accommodate different product configuration. The operation sequence is controlled by a program, which is a set of instructions coded so that they can be read and interpreted by the system. New programs can be: prepared and entered into the equipment to produce new products. Some of the features that characterize programmable automation include' • high investment in general purpose equipment • lower production rates than fixed automation • flexibility to deal with variations and changes in product configuration • most suitable for batch production **Flexible Automation**. Flexible' automation is an extension of programmable automation. A flexible automated system is capable of		7	7

	producing a variety of parts with virtually no time lost for changeovers from one part style to the next. There is no lost production time while reprogramming the system and altering the physical setup (tooting, fixtures, machine settings). Consequently, the system can produce various combinations and schedules of parts or products instead of requiring that they be made in batches. What makes flexible automation possible is that the differences between parts processed by the system are not significant. It is a case of soft variety. So that the amount of changeover required between styles is minimal. The features of flexible automation can be summarized as follows • high investment for a custom-engineered system • continuous production of variable mixtures of products			
III. 3	**High accuracy**: The measurement contains small systematic errors about the true value. **High precision**: The random variability or noise in the measured value is low. **Wide operating range**: The measuring device possesses high accuracy and precision over a wide range of values of the physical variable being measured. **High speed of response**: The ability of the device to respond quickly to changes in the physical variable being measured. . Ideally. The time lag would be zero. **Ease of calibration**: Calibration of the measuring device should be quick and easy. **Minimum drift**: Drift refers to the gradual loss in accuracy over time. High drift requires frequent recalibration of the measuring device **High reliability**: The device should not be subject to frequent malfunctions or failures during service. It must be capable of operating in the potentially harsh environment of the manufacturing process where it will be applied. **Low cost**: The cost to purchase or fabricate and install the measuring device should be low relative to the value of the data provided by the sensor.		7	7

III. 4	We can identify five possible levels of automation in a production plant. 1. **Device level**: This is the lowest level in our automation hierarchy. It includes the actuators, sensors, and other hardware components that comprise the machine level. The devices are combined into the individual control loops of the machine; for example, the feedback control loops for one axis of a CNC machine or one joint of an industrial robot. 2. **Machine level**: Hardware at the device level is assembled into individual machines. Examples include CNC machine tools and similar production equipment, industrial robots, powered conveyors, and automated guided vehicles. Control functions at this level include performing the sequence of steps in the program of instructions in the correct order and making sure that each step is properly executed. 3. **Cell or system level:** This is the manufacturing cell or system level, which operates under instructions from the plant level. A manufacturing cell or system is a group of machines or workstations connected and supported by a material handling system, computer. and other equipment appropriate to the manufacturing process. Production lines are included in this level. Functions include part dispatching and machine loading. Coordination among machines and material handling system, and collecting and evaluating inspection data. 4. **Plant level**: This is the factory or production systems level. It receives instructions from (the corporate iuforrnation system and translates them into operational plans for production. Likely functions include: order processing, process planning, inventory control, purchasing, material requirements planning, shop floor control, and quality control. 5. **Enterprise level**: This is the highest level consisting of the corporate information system. It is concerned with all of the functions necessary to manage the company: marketing and sales, accounting, design, research, aggregate planning, and master production scheduling.		7	7

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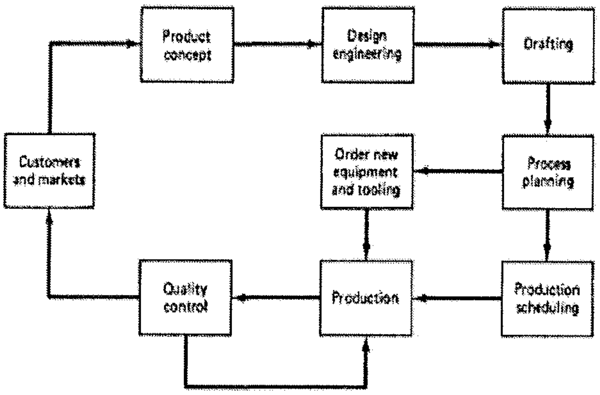
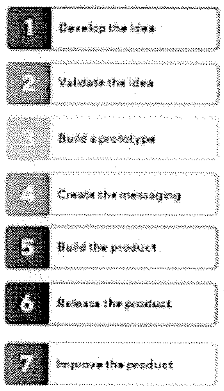
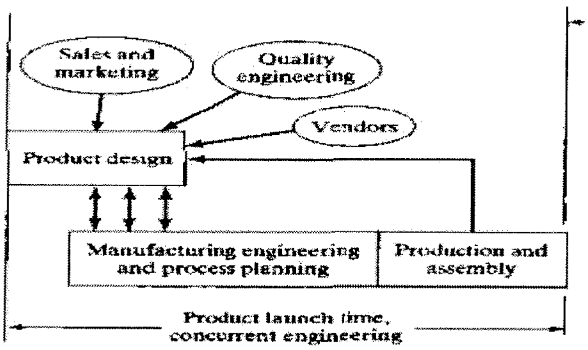
<tr><td>III. 5</td><td>

Product Development Cycle


</td><td></td><td>7</td><td>7</td></tr>
<tr><td>III. 6</td><td>Concurrent engineering refers to 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. Also called simultaneous engineering, it might be thought of as the organizational counterpart to CAD/CAM technology.



Elements of concurrent Engineering
1.Design for Manufacturing and Assembly
Minimize number of components
Use standard commercially available components
Use common parts across product lines
Design for ease of part fabrication
Design parts with tolerances that are within process capability
Design the product to be foolproof during assembly
Minimize flexible components
Design for ease of assembly.
Use modular design</td><td></td><td>7</td><td>7</td></tr>
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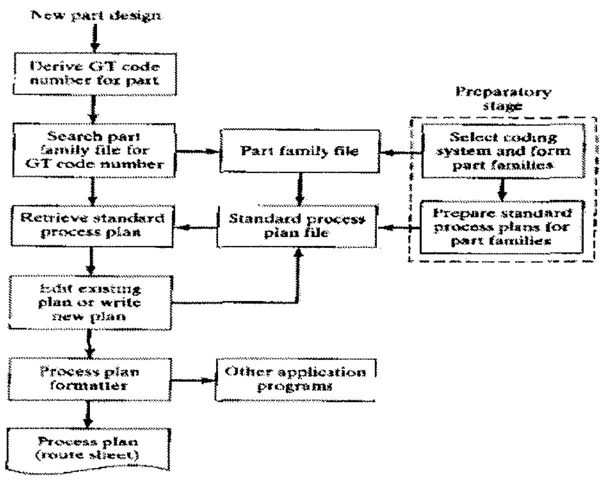
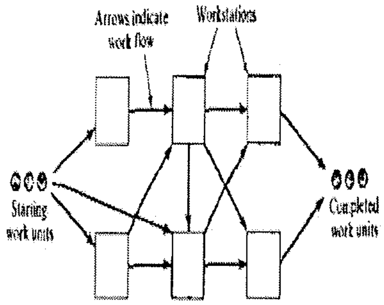
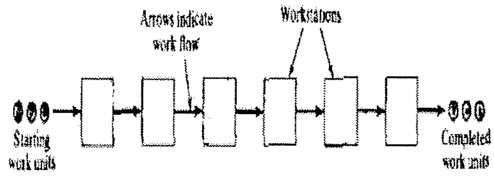
	• Shape parts and products for ease of packaging • Eliminate or reduce adjustments **2. Design for Quality.** Design for quality (DFQ) is the term that refers to the principles and procedures employed to ensure that the highest possible quality is designed into the product. The general objectives of DFQ are (1) to design the product to meet or exceed customer requirements; (2) to design the product to be "robust," that is, to design the product so that its function and performance are relatively insensitive to variations in manufacturing and subsequent application; and (3) to continuously improve the performance, functionality, Reliability, safety. And other quality aspects of the product to provide superior value to the customer. **3. Design for Product Cost.** DFC refers to the efforts of a company to specifically identify how design decisions affect product costs and to develop ways to reduce cost through design. Although the objectives of DFC and DFM/A overlap to some degree, since improved manufacturability usually results in lower cost, the scope of design for product cost extends beyond only manufacturing in its pursuit of cost savings, **4. Design for Life Cycle** Design for life cycle refers to the product after it has been manufactured and includes factors ranging from product delivery to product disposal.			
III. 7	End effector is usually attached to the robot's wrist. The end effector enables the robot to accomplish a specific task. The two categories of end effectors are grippers and tools. **Grippers:** Grippers are end effectors used to grasp and manipulate objects during the work cycle. The objects are usually work parts that are moved from one location to another in the cell. Machine loading and unloading applications fall into this category Types of grippers used in industrial robot applications include the following: • mechanical grippers, consisting of two or more fingers that can be actuated by the robot controller to open and dose to grasp the work part • vacuum grippers, in which suction cups are used to hold flat objects • magnetized devices, for holding ferrous parts • adhesive devices, where an adhesive substance is used to hold a flexible material such as a fabric • Simple mechanical devices such as hooks and scoops. **Tools:** Tools are used in applications where the robot must perform some processing operation on the work part. Examples of the tools used as end effectors by robots to perform processing applications include • spot welding gun • arc welding tool • spray painting gun • rotating spindle for drilling, routing. grinding, and so forth • assembly tool (e.g., automatic screwdriver) • heating torch • Water jet cutting tool.		7	7
III. 8	**Advantages of NC** • Nonproductive time is reduced. • Greater accuracy and repeatability. • Lower scrap rates • Inspection requirements are reduced. • More-complex part geometries are possible		7	7

	• Engineering changes can be accomadated more gracefully • Simpler fixtures are Needed • Shorter manufacturing lead times • Reduced inventory • Less floor space • Low level of operator skill			
III. 9	Manufacturing Applications. **1)Informal scheduling and routing of similar parts through selected machines :** This approach achieves setup advantages but no formal part families are defined, and no physical rearrangement of equipment is undertaken. **2) Virtual machine cells :** This approach involves the creation of part families and dedication of equipment to the manufacture of these part families, but without the physical rearrangement of machines into formal cells. The machines in the virtual cell remain in their original locations in the factory. **3) Formal machine cells :** This is the conventional GT approach in which a group of dissimilar machines are physically relocated into a cell that is dedicated to the production of one or a limited set of part families. The machines in a formal machine cell are located in close proximity to minimize part handling, throughput time, setup time, and work-in-process. Other GT applications in manufacturing include process planning, family tooling, and numerical control (NC) part program. **Product design Applications :** The application of group technology in product design is found principally in the use of design retrieval systems that reduce part proliferation in the firm. Other design applications of group technology involve simplification and standardization of design parameters, such as tolerances inside radii on corners, chamfer sizes on outside edges, hole sizes, thread sizes, and so forth. These measures simplify design procedures and reduce part proliferation. Design standardization also pays dividends in manufacturing by reducing the required number of distinct lathe tool nose radii, drill sizes, and fastener sizes. There is also a benefit in terms of reducing the amount of data and information that the company must deal with. Fewer part designs, design attributes, tools, fasteners, and so on mean fewer and simpler design documents, process plans, and other data records.		7	7

III.10	 A retrieval CAPP system, also called a variant CAPP system, is based on the principles of group technology (GT) and parts classification and coding . In this type of CAPP, a standard process plan (route sheet) is stored in computer files for each part code number. The standard route sheets are based on current part routings in use in the factory or on an ideal process plan that has been prepared for each family. It should be noted that the development of the data base of these process plans requires substantial effort.		7	7
III. 11	**Material Transport Equipment** **a) Industrial trucks:** Industrial trucks divide into two types: non-powered and powered. Nonpowered trucks are platforms or containers with wheels that are pushed or pulled by human workers to move materials. Powered industrial trucks are steered by human workers. They provide mechanized movement of materials. **(b) Automated guided vehicles (AGVs):** AGVs are battery-powered, automatically steered vehicles that follow defined pathways in the floor. The pathways are unobtrusive. AGVs are used to move unit loads between loads and unload stations in the facility. Routing variations arc possible, meaning that different loads move between different stations. They are usually interfaced with other systems to achieve the full benefits of integrated automation. **(c) Monorail and other rail guided vehicles:** These are self-propelled vehicles that ride on a fixed rail system that is either on the floor or suspended from the ceiling. The vehicles operate independently and are usually driven by electric motors that pick up power from an electrified rail. Like AGVs,routing variations are possible in rail-guided vehicle systems. **(d) Conveyors:** Conveyors constitute a large family of material transport equipment that are designed to move materials over fixed paths, generally in large quantities or volumes. Examples include-roller, belt and tow-line conveyors. Conveyors can be either powered or nonpowered. Powered conveyors are distinguished from other types of powered material transport equipment in that the mechanical drive system is built into the fixed path. Nonpowered conveyors are activated either by human workers or by gravity. **(e) Cranes and hoists:** These are handling devices for lifting, lowering, and transporting materials, often as very heavy loads. Hoists accomplish vertical lifting; both manually operated and powered types are available. Cranes provide horizontal travel and generally include one or more hoists.		7	7

III. 12	**Multi-station automated system with fixed routing :** This system consists of two or more automated stations (n > 1, w == 0, M < 1) arranged as a production line. Work transport is fully automated. **Multi-station automated system with variable routing:** This is the same as muti-station manual system with variable routing, except the stations are fully automated (n > 1, w, = 0, M < 1). Work transport is also fully automated.  (a)  		7	7