Solution of Midterm as Follows

Q1.(A) Explain the role of computer in manufacturing?

Ans: Computer based control systems can be combined with manufacturing technology, such as robots, machine tools, automated guided vehicles, to improve manufacturing operations. In this role, the computer can assist integrating these technologies into a lean and efficient factory capable of competing in world markets. Organizations have used computer technology and factory automation to improve manufacturing operations. This combination of information technology and factory automation is often called computer- integrated manufacturing. Computer- integrated manufacturing (CIM) blends development in manufacturing with information technology to achieve competitive advantage. When properly organized, CIM offers the opportunity to automate design, manufacturing and production planning and control. Each component is described briefly here: Engineering design through Computer aided design (CAD) allows an organization to make high quality specialized designs rapidly. The design can be tailored to meet individual customer needs. Flexibility manufacturing systems (FMSs) can quickly produce a variety of high quality product efficiently. An (FMSs) also allow an organization to produce high specialized designs. Computer based production planning and control systems allow an organization to cope with the complexity of managing facilities that produce a wide variety of specialized products without losing efficiency. When properly combined, these components can yield synergetic results. An organization can have more flexible and integrated operations, be better equipped to manage complex operations, and exercise better controls then can a company that operates without CIM. To merge these components into one coordinated whole, staff from the information systems functions needs to integrate engineering, manufacturing, and business databases into a cross functional decision support system. Once accomplished, the flexibility to respond to customer demands with low cost, high quality specialized products becomes a powerful competitive advantage.

Q1. (B)What is Numerical Control ?Explain its components?

Ans: Numerical control can be defined as a form of programmable automation in which process is controlled by numbers, letters and symbols. In NC, numbers form a programme of instructions designed for a particular work part or job. When job changes the program of instruction changes. This capability to change a program for each new job gives NC its flexibility. Numerical control should be considered as a possible mode of controlling the operation for any production situation possessing the following characteristics : Similar work parts in terms of raw material (e.g. metal shock for machining)
The work parts are produced in various sizes and geometries.
The workparts are produced in batches of small to medium size quantities.
A sequence of similar processing steps is required to complete the operation on each work piece.
Many machining jobs meet these conditions. The machined workparts are metal, they are specified in many different sizes and shapes, and most machined parts produced in the industry today are made in small to medium size lots sizes. To produce each parts a sequence of drilling operations may be required

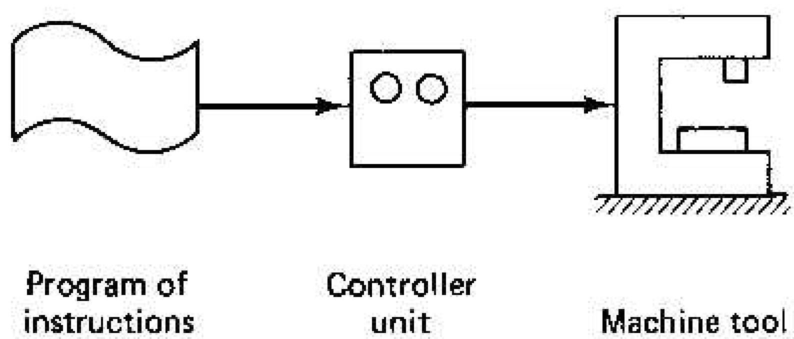
as a series of turning or milling operations. The suitability of NC for these kinds of jobs is the reason of tremendous growth of numerical control in metal working industry over the last 25 years.

Basic components of NC system

An operational numerical control system consists of the following three basic components:

1. Program of instructions.
2. Controller unit also called machine tool unit.
3. Machine tool or other controlled process.

The program of instructions serves as input to the controller unit, which in turn commands the machine tool or other process to be controlled.



7.1 Three basic components of a numerical control system.

Program of Instructions.

The program of instructions is the detailed step by step set of instructions which tell the machine what to do. It is coded in numerical or symbolic form on some type of input medium that can be interpreted by the controller unit. The most common one is the 1-inch-wide punched tape. Over the years, other forms of input media has been used, including punched cards, magnetic tape, and even 35mm motion picture film. There are two other methods of input to the NC system which should be mentioned. The first is by manual entry of instructional data to the controller unit. This is time consuming and is rarely used except as an auxiliary means of control or when one or a very limited no. of parts to be made. The second method of input is by means of a direct ling with the computer. This is called direct numerical control, or DNC.

Controller Unit

The second basic component of NC system is the controller unit. This consists of electronics and hardware that read and interpret the program of instructions and convert it to mechanical actions of the machine tool. The typical elements of the controller unit include the tape reader, a data buffer, signal output channels to the machine tool, and the sequence controls to coordinate the overall operation of the foregoing elements. The tape reader is an electrical-mechanical device for the winding and reading the punched tape containing the program of instructions. The signal output channels are connected to the servomotors .and other controls in machine tools. Most N.C. tools today are provided with positive feedback controls for this purpose and are referred as closed loop systems. However there has been growth in the open loop systems which do not make use of feedback signals to the controller unit. The advocates of the open loop concept claim that the realiblity of the system is great enough that the feedback controls are not needed.

Machine Tool

The third basic component of an NC system is the machine tool or other controlled process. It is part of the NC system which performs useful work. In the most common example of an NC system,one designed to perform machining operations, The machine tool consists of the worktable and spindle as well as the motors and controls necessary to drive them. It also includes the cutting tools,work fixtures and other auxiliary equipment needed in machining operation.

OR

Q1.(A) Explain in detail about direct numerical control, its functions and Application criteria ?

Ans : The abbreviation DNC originally stood for **direct numerical control.** Recently, terms such as distributed numerical control and distributive numerical control also have been used. This term refers to a mode of operation in which multiple NC- or CNC-machines and other production equipment (e.g., tool-presetting devices, measuring machines, and robots) are connected to a computer by cables. The direct transmission of data has eliminated the data-storage media that previously were used commonly (e.g., punched tapes, magnetic tapes, and diskettes) as well as the devices required for reading and writing to these media. This brought several technical and economic benefits.

The essential feature of direct numerical control is the "management and timely distribution of control information to multiple NC machines, in which the computer can assume responsibility for the numerical control functions." The last phrase no longer applies to modern DNC systems, however. Machine controlfunctions now remain within the purview of the CNC system. The data networks and powerful DNC software allow all systems connected to the local-area network (LAN) to communicate with one another.

Functions of DNC

Although the specific technologies have changed greatly in recent years, the basic functions of DNC systems have remained the same even today. A DNC system has to fulfill two basic tasks:

- Guaranteeing secure, timely data transfer from and to the CNC controllers
- Administering many thousands of NC programs

The first task, guaranteeing secure data transfer, protects the company in question against the possibility of expensive damage to the machine and work pieces. NC program management, on the other hand, ensures the proper organization and storage of what are generally large amounts of data that represent a significant monetary investment. Both these tasks can be solved by means of a modern system, thus contributing significantly to increased production and quality assurance in the manufacturing process.

The VDE guideline that appeared in 1972 already made a distinction between basic functions and expanded functions of DNC systems, such as tool management and workpiece management in highly automated manufacturing systems. This will be discussed in greater detail below.

Application Criteria for DNC Systems

A company's requirement for introducing a DNC system can be based on a number of criteria. These include

1. Frequent program changes- The smaller the lot size, the greater is the problem of always having the correct NC program available at the right machine at the right time. In DNC operation, the NC program is available in the machine immediately after being called. In expanded systems, all the additional data, compensation values, and operator information are also available.

2. Number of NC and CNC machines- Profitable DNC operation can begin even with two to three NC machines, provided that a number of program changes are necessary every day. The arguments for DNC increase with each additional machine. In fact, some manufacturing processes assume that data will be provided via a DNC system.

3. Number of NC programs- The problems of administering several thousand NC programs with the associated modifications, updates, and changes can hardly be managed without the use of computers. A DNC system makes this work easier and minimizes the risk of human errors.

4. Program length- If programs are too large so that a number of portable data-storage media would be required, then there is a risk of confusing them, with potentially costly consequences. If the programs are larger than the memory capacity of the CNC machine, then a DNC system may be essential even for a single machine in order to be able to operate without interruption even for several hours.

5. Many new programs- If a company depends on many new programs or frequent program modifications, then the direct transfer of programs from the computer-aided design (CAD)/computer-aided manufacturing (CAM) system to the CNC system is essential. Especially with shop-floor programming, that is, programming directly at the machines by the machine operators, it is very important to be able to save the programs that are generated.

6. High transmission rate-. Especially high speed cutting (HSC) machines and laser technologies require an extremely high data throughput. It is therefore necessary to transfer the NC program data to the CNC system very quickly so that the machining process does not stop owing to a lack of data. This requirement can only be satisfied with DNC systems.

7. Computer-aided tool management- Integrated management of tools and tool data can provide enormous cost savings. Better use can be made of tool lives, and unnecessary breakdown and assembly are avoided. The summarized transfer to the CNC systems of tool numbers with all the tool data reduces the time requirements and increases the safety.

8. Flexible manufacturing systems- Flexible manufacturing systems represent a special group that is categorized by that fact that both basic DNC functions and the recording, storage, and management of pallets, compensation values, measurement data, and so on are performed by a special host computer**.** This is generally provided by the supplier of the overall system and is equipped with a specially adapted, expanded software.

Question1(B): What do you understand by Computer assisted Part programming(APT)?

Ans: APT: Automatically Programmed Tooling is a three-dimensional NC programming system. APT is not only a language; it is also the computer program that processes the APT statements to calculate the corresponding cutter positions and generate the machine tool control commands.

Computer-Assisted Part Programming - In computer-assisted part programming (APT), the machining instructions are written in English-like statements that are subsequently translated by the computer into the low-level machine code that can be interpreted and executed by the machine tool controller.

When using one of the part programming languages, the two main tasks of the programmer are:

(1) Defining the geometry of the work part.

(2) Specifying the tool path and operation sequence.

To program in APT, the part geometry must first be defined. Then the tool is directed to various point locations and along surfaces of the work part to accomplish the required machining operations. The viewpoint of the programmer is that the work piece remains stationary, and the tool is instructed to move relative to the part. To complete the program, speeds and feeds must be specified, tools must be called, tolerances must be given for circular interpolation, and so forth.

There are four basic types of statements in the APT language:

1. Geometry statements, also called definition statements, are used to define the geometry elements that comprise the part.

2. Motion commands are used to specify the tool path

3. Postprocessor statements control the machine tool operation, for example, to specify speeds and feeds, set tolerance values for circular interpolation, and actuate other capabilities of the machine tool.

4. Auxiliary statements, a group of miscellaneous statements used to name the part program, insert comments in the program and accomplish similar functions.

Q2. (A) Write advantages of CNC machines?

Ans: Advantages of the CNC Machines

There are various valid reasons for the popularity of the CNC machines over the NC machines, let us see some of them.

1. Part program tape and tape reader: In the older CNC machines the part program tape and the tape reader is still required, but they are used only for feeding the program into the memory of the computer. Once the program is saved into the memory, the tape is no more required and the program stored in the

memory can be used repeatedly. Thus the tape and the tape reader that poses the major maintenance problems are done away with. In fact the latest CNC machine don't even require the tape and tape reader, for the program of instructions are fed directly into the mini or microcomputer via the control panel of the computer.

2. Editing the program: Since the program of instructions is saved in the computer memory, they can be edited and changed as per the requirements. Thus the CNC system is highly flexible. One can also make necessary changes in the program for providing variable speeds and feeds for the manufacture of the jobs resulting in economic manufacturing. Even the NC tape used for the programming in CNC machines can be corrected and optimized since it allows changes in the tool path, speed, feed etc.

3. Metric conversion: The CNC machine allows the conversion of tapes prepared in the metric system into the SI system of measurements. Thus programmer does not have to re-enter the whole program of instructions merely because of the different units of measurements used in the program.

4. Highly flexible: The CNC machines are highly flexible. One can easily make the changes in the program and store them as the new program. One can also introduce new control options like the new interpolation scheme quite easily. It is easier to make updates in the CNC machines with lesser cost; hence risk of the obsolescence of the CNC machine is reduced.

5. Easier programming: The programs are written in the CNC machine using language which has statements similar to the ordinary English language statements. The programmer can easily master the CNC programming language and use it for the wide range of the machining operations of the job. The programmer can set the various dimension of the job, the machining operations to be carried out and their sequence, the amount of metal to be removed in each cutting operation, the speed of cutting, etc. The program of instructions is written as per the available size of the raw materials and also the surface finish required for the final finished job. Some of the programs take the form of the macro subroutines stored in the memory of the CNC machine and the programmer can use them frequently whenever required. Some of the programs are stored in the library and they can be used wherever required completely or as a small part of the big program.

Q2. (B) What are the problems in NC Machines?

Ans: Here are some of the problems associated with the conventional NC machines:

1. Mistakes related with part programming (programming for the parts to be manufactured): When the programs of instructions related to the particular part to be manufactured are written on the punched tape, the syntax or numerical mistakes are quite common. The NC tape is not completed correctly in a single pass and at least three passes are required to get the correct program written. Another major problem with the part programming is achieving the best sequence of steps required for the machining the part manufacturing of the object from the raw material it should be given optimum speed and feeds during manufacturing. The conventional numerical control does not provide opportunity to change the speeds and feeds during the cutting operations, so the programmer is compelled to set the speeds and feeds for the worst-case conditions that can result in highly expensive manufacturing due to wastages, and low quality jobs. This also results in manufacturing of the jobs at lower than optimum productivity.

2. Punched tape: The punched, which is made up of paper and on which the program is written is the problem in itself. This tape is fragile and susceptible to wear and tear so it has short life and cannot be reliable enough for the repeated use. Instead of paper, other media like Mylar can be used for writing the program of instructions, but these materials are quite expensive.

3. Unreliable tape reader: The tape reader reads the program of instructions from the punched tape, but it is considered to be highly unreliable hardware component of the NC machine. When the NC machine breaks down the first thing the maintenance personnel checks is the tape reader.

4. The inflexible controller: The conventional NC machine has the controller unit which is hard wired and the making the changes in the controls of the machines is a tough task. The controller used in the CNC machines is the computer, which is highly flexible.

5. Important information: The conventional NC machine cannot provide crucial information to the operator and the supervisor like the number of pieces manufactured, tools changes and others.The problems associated with the NC machines have been solved over the time with the improvement in the NC technology mostly due to advancement in the electronics. The major change obviously came when mini or microcomputers were introduced in the NC system. The computers have had major impact on the NC system and with their introduction the whole technology has come to be known as the CNC (computer numerical control) technology. For the common man and also to the engineers the automatic machine tools are now known by the name CNC machines and not the NC machines.

Q2.(A) Explain the concept of part programming? Differentiate Manual and Computer assisted part programming in brief?

Ans: Part Program: The part program is a sequence of instructions, which describe the work, which has to be done on a part, in the form required by a computer under the control of a numerical control computer program. It is the task of preparing a program sheet from a drawing sheet. All data is fed into the numerical control system using a standardized format. Programming is where all the machining data are compiled and where the data are translated into a language which can be understood by the control system of the machine tool. The machining data is as follows : (a) Machining sequence classification of process, tool start up point, cutting depth, tool path, etc. (b) Cutting conditions, spindle speed, feed rate, coolant, etc. (c) Selection of cutting tools. While preparing a part program, need to perform the following steps : (a) Determine the startup procedure, which includes the extraction of dimensional data from part drawings and data regarding surface quality requirements on the machined component. (b) Select the tool and determine the tool offset. (c) Set up the zero position for the workpiece. (d) Select the speed and rotation of the spindle. (e) Set up the tool motions according to the profile required. (f) Return the cutting tool to the reference point after completion of work. (g) End the program by stopping the spindle and coolant. The part programming contains the list of coordinate values along the X, Y and Z directions of the entire tool path to finish the component. The program should also contain information, such as feed and speed. Each of the necessary instructions for a particular operation given in the part program is known as an NC word. A group of such NC words constitutes a complete NC instruction, known as block. Hence the methods of part programming can be of two types depending upon the two techniques as below :

(a) Manual part programming

(b) Computer aided part programming.

Manual Part Programming

The programmer first prepares the program manuscript in a standard format. Manuscripts are typed with a device known as flexo writer, which is also used to type the program instructions. After the program is typed, the punched tape is prepared on the flexo writer. Complex shaped components require tedious calculations. This type of programming is carried out for simple machining parts produced on point-to-point machine tool. To be able to create a part program manually, need the following information : (a) Knowledge about various manufacturing processes and machines. (b) Sequence of operations to be performed for a given component. (c) Knowledge of the selection of cutting parameters. (d) Editing the part program according to the design changes. (e) Knowledge about the codes and functions used in part programs. Fundamentals of Part Programming

Computer Aided Part Programming

If the complex-shaped component requires calculations to produce the component are done by the programming software contained in the computer. The programmer communicates with this system through the system language, which is based on words. There are various programming languages developed in the recent past, such as APT (Automatically Programmed Tools), ADAPT, AUTOSPOT, COMPAT-II, 2CL, ROMANCE, SPLIT is used for writing a computer programme, which has English like statements. A translator known as compiler program is used to translate it in a form acceptable to MCU. The programmer has to do only following things : (a) Define the work part geometry. (b) Defining the repetition work. (c) Specifying the operation sequence. Over the past years, lot of effort is devoted to automate the part programme generation. With the development of the CAD (Computer Aided Design)/CAM (Computer Aided Manufacturing) system, interactive graphic system is integrated with the NC part programming. Graphic based software using menu driven technique improves the user friendliness. The part programmer can create the geometrical model in the CAM package or directly extract the geometrical model from the CAD/CAM database. Built in tool motion commands can assist the part programmer to calculate the tool paths automatically. The programmer can verify the tool paths through the graphic display using the animation function of the CAM system. It greatly enhances the speed and accuracy in tool path generation.

Q2.(B) Briefly introduce Adaptive Control Machine Tools and its Functions?

Ans: **ADAPTIVE CONTROL MACHINING**

INTRODUCTION

Adaptive control system is a logical extension of the CNC-mechanism. In CNC mechanism the cutting speed and feed rates are prescribed by the part programmer. The determination of these operating parameters depends on the Knowledge and experience regarding the work piece, tool materials, coolant conditions and other factors. By contrast in adaptive control machining, there is improvement in the production rate and reduction in the machining cost as a result of calculating and setting of optimal parameters during machining. This calculation is based on measurements of process variables in real time and followed by a subsequent on-line adjustments of the parameters subjected to machining constraints in order to optimize the performance of the overall system. Adaptive control (AC) machining originated out of research in early 1970's sponsored by U.S Air Force. The initial adaptive control systems were based on analog devices, representing the technology at that time. Today adaptive control uses microprocessor based controls and is typically integrated with an existing CNC system. Adaptive control possesses attributes of both feedback control and optimal control. Like a feedback system measurements are taken on certain process variables. Like an optimal system, an overall measure of performance is used. In adaptive control, this measure is called the index of performance (IP). The feature that distinguishes adaptive control from other two types is that an adaptive system is designed to operate in a time varying environment. It is not usual for a system to exist in environments that change over the course of time. An adaptive control system is designed to operate for the changing environment by monitoring its performance and altering accordingly, some aspects of its control mechanism to achieve optimal or near optimal routine. The feedback and optimal systems operate in a known or deterministic environment. If the environment changes significantly, these systems might not respond in the manner intended by the designer. On the other hand, the AC system evaluates the environment, more accurately. It evaluates its performance within the environment and makes the necessary changes in its control characteristics or if possible, to optimize its performance.

FUNCTIONS OF ADAPTIVE CONTROL

The three functions of adaptive control are:

1. Identification function.

2. Decision function.

3. Modification function.

IDENTIFICATION FUNCTIONS This involves determining the current performance of the process or system. Normally, the performance quality of the system is defined by some relevant index of performance. The identification function is concerned with determining the current value of this performance measure by making use of the feedback data from the process. Since the environment will change overtime, the performance of the system will also change. Accordingly the identification is one that must proceed over time or less continuously. Identification of the system may involve a number of possible measurements activities.

DECISION FUNCTION Once the system performance is determined, the next function is to decide how the control mechanism should be adjusted to improve process performance. The decision procedure is carried out by means of a pre-programmed logic provided by the designer. Depending upon the logic the decision may be to change one or more of the controllable process.

MODIFICATION FUNCTION The third AC function is to implement the decision. While the decision function is a logic function, modification is concerned with a physical or mechanical change in the system. It is a hardware function rather than a software function. The modification involves changing the system parameters or variables so as to drive the process towards a more optimal state. The process is assumed to be influenced by some time varying environment. The adaptive system first identifies the current performance by taking measurements of inputs and outputs. Depending on current performance, a decision procedure is carried out to determine what changes are needed to improve system performance. Actual changes to the system are made in the modification function.