V Semester Diploma Examinations, Feb/March 2023

Advanced Manufacturing Technologies

SUB CODE: 20ME53IT **MAX MARKS:100**

SCHEME OF VALUATION

SECTION-I

1(a) List 1/2x4=2 Marks, Justification-3 Marks, Advantages-3 Marks, applications-2 Marks

1(b) Justification-4 Marks Advantages-4 Marks, Dis-advantages-2 Marks

2(a) Explanation- 6 Marks, applications-4 Marks

2(b) Any 5 important steps - 5X2=10 Marks

SECTION-II

3(a) Properties (any 4 type) 1.5x4=6M and applications (any 4 type 1/2x2) 1+1+1+1=4Marks

3(b) Benefits -4M, Different technologies 2M, Applications -1/2x8=4M

4(a) Formula 2+2 Marks, Substitution 2+2 marks, final answer 1+1 mar=1 0 Marks

4(b) Suggestion-2 Marks , Explainationt-8Marks

SECTION-III

5(a) List – 1/2x6=3 Marks, Explanation-3 Marks, Advantages 0.5x8=4M

5(b) Suggestion-5 Marks , Argument-5M

6(a) Importance- 4Marks, Benefits(any 3)- 3Marks, and need(any 3)-3marks

6(b) Line diagram-3marks, working priciple-7 marks

SECTION-IV

7(a) working principle with line diagram-10 Marks,

7(b) Each level 2x5=10 Marks

8(a) working principle with line diagram-10 Marks,

8(b)) Explanation of each 5x2=10Marks

SECTION-V

9(a) Sketch-5 Marks, working=5 Marks

9(b) Selection of **suitable process** 2, Steps- 6Marks, Justification-2 Marks

10(a) Sketch-4 Marks , working-4Marks, Drabacks-2Marks (Any 2)

10(b)Definitions each 2x2=4 Marks, any 6 difference 6x1=6 Marks

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MODEL ANSWERS

Note: The model answers only for reference, alternate answers can also be considered.

Section-1

1 a). The materials used in manufacturing of automobiles / locomotive have changed lot now as compared to early years. With objects of reducing weight and increase fuel efficiency, what are the advanced materials are used in manufacturing of Automobiles and Locomotive? Justify your answer with materials advantages and uses.

Ans: The advanced materials are used in manufacturing of automobiles and locomotive are

i) Laminated composites/composites.

ii) Magnesium

iii) Aluminium alloys

iv) Carbon fiber composites

v) Titanium etc

Justification: The growing challenges on fuel economy improvement and greenhouse gas emission control have become the driving force for automakers to produce lightweight automobiles. Also, the weight reduction may contribute to superior recyclability and/or vehicle performance. One effective strategy is to develop and implement lightweight yet high-performance materials as alternative solutions for conventional automotive materials such as cast iron and steel. Lightweight materials to produce next-generation automobiles is provided, including light alloys, high-strength steels, composites, and advanced materials reducing weight and increase fuel efficiency and also improved driving economy, braking behaviours, and crashworthiness.

Advantages of advanced materials.

i) Light weight.
ii) High strength.
iii) Good corrosion resistance.
iv) High-temperature resistance.
v) High compression resistance.

Applications of Advanced materials

Military aircraft. Automotive. Electronics industries. Space systems. Medical equipment. Construction of bridges. Corrosive Environments. Aerospace. Oil and gas industries. Sports items.

1 b). Discuss non-traditional manufacturing methods are better than traditional manufacturing methods. Justify your answer and also list advantages and disadvantages.

Ans: The greatly improved thermal, chemical, and mechanical properties of the new engineering materials made it impossible to machine them using the traditional machining processes of cutting and abrasion. This is because traditional machining is most often based on the removal of material using tools that are harder than the work piece. For example, the high ratio of the volume of grinding wheel worn per unit volume of metal removed (50–200) made classical grinding suitable only to a limited extent for production of poly crystalline diamond (PCD) profile tools.

The high cost of machining ceramics and composites and the damage generated during machining are major obstacles to the implementation of these materials. In addition to the advanced materials, more complex shapes, low-rigidity structures, and micromachined components with tight tolerances and fine surface quality are often needed. Traditional machining methods are often ineffective in machining these parts. To meet these demands, new processes are developed. These methods play a considerable role in the aircraft, automobile, tool, die, and mould making industries.

Advantages

i) Improved thermal, chemical properties
ii) Improved mechanical properties.
iii) No wear and tear of the tool materials.
iv) More complex shapes machining can do easily.
v) Micro-machined components with tight tolerances can get.
vi) Fine surface quality.
vii) clean working area.
viii) low-rigidity structures can machine

easily. Disadvantages.

i) Initial investment more
ii) Cost of the machine is very high
iii) Trained works are needs for operation.
iv) Low Material removal process

2 a) Point out super alloys and ceramics materials used in high temperature applications ? explain. List the applications.

Ans: **superalloys and ceramics** are generally known difficult to machine materials because of their toughness, high heat resistance and high operating temperatures, hardness, strength to weight ratio and chemical property to react with tool materials, low thermal conductivity and creep resistance. Although these whole properties are necessary design requirements, they cause a greater challenge to manufacturing engineers due to the high temperatures and

stresses generated during machining. The tool materials with better hardness like carbides, ceramics and CBN are regularly used for machining of Super alloys. Betterments in machining productivity can be attaining with the advanced machining techniques such as rotary machining. The superalloys mainly used to turbine parts as well as high temperature elements.

Applications:

i) used in air craft
ii) power generation turbines
iii) rocket engines
iv) chemical processing
v) nuclear power plants
vi) aero gas turbine
vii) jet engines
viii) Turbine materials, both disc and blades
ix) applications in the oil and gas industry

2b) Discuss the importance of steps in chemical machining method.

Ans: Importance of steps are

i) Cleaning ii) Scribing iii) Masking iv) Etching v) Demasking

i) Clean: Preparing and precleaning the workpiece surface for chemical machining. This provides good adhesion of the masking material and assures the absence of contaminants that might interfere with the machining process.

i) Scribing: Scribing templates are used to define the areas for exposure to the chemical machining action. The most common workpiece scribing method is to cut the mask with a sharp knife followed by careful peeling of the mask from the selected areas.

ii) Masking: Maskants are generally used to protect parts of the workpiece where Chemical machining action is not needed. Synthetic or rubber base materials are frequently used.

iii) Etching: When the mask is used, the machining action proceeds both inwardly from the mask opening and laterally beneath the mask thus creating the etch, this process is called etching.

iv) Demasking: The process of removing the maskants from the machined parts, after the chemical machining.

Section-2

3a) In additive manufacturing, the material properties are being established alongside the geometry of the part. There are different classes of materials used in additive manufacturing. Differentiate these different materials used in AM with respect to their Properties and Applications.

Ans:

In additive manufacturing, however, the material properties are being established alongside the geometry of the part. The raw material has an impact (i.e. the chemical makeup of the

polymer, the size and distribution of metal powder particles) but process parameters also play a role in factors such as strength, ductility, porosity and surface finish of the final part. This brings new challenges unique to additive, but also opportunities. When the material properties are determined alongside the geometry, it becomes possible to intentionally and precisely control those properties in specific regions of the part — to introduce properties such as porosity, or stiffness, or flexibility.

Materials are

Ceramics, Silicon carbides, Aluminium oxide, Cement

Properties are,

High hardness. • High elastic modulus. • Low ductility. • Good wear resistance.

Applications are,

In space industry. • In thermal insulator. • Electric application. • Modern industries.

Plastics

Acrylanitride Butadiene Styrene (ABS) 2. Polylactide (PLA) 3. Polycarborate (PC) 4. Polyvinyl Chloride (PVC)

Properties- • They are light weight and chemically stable. • Low thermal condectivity. • They don't rust. • Poor dimension stability.

Applications-

In elecrtical applications. • Manufacturing industries. Health care application. • Textile applications. • Medical equipments. • Agricaltural applications.

Polyethylene terephthalate (PET)-

Polyethylene terephthalate or PET is commonly seen in disposable plastic bottles. Due to higher chemical resistance and rigid compositions, PET is used in manufacturing plastic containers used in packaging food.

Properties are,

Good durablity. • recyclable material. • Good strength • temperature resistance.

Applications are,

food packaging industry. • Fruit container. • Sinthetic clocks • Electronic applications.

3b) Uniform wares explores the advantages of additive manufacturing(AM) technology, pushing the boundaries of design in an industry traditionally centred around maintenance. What are the benefits of additive manufacturing ? Defferentiate the technologies available in additive manufacturing and list their applications.

Ans:

Ans-

Additive technology is known as the use of 3d printing techniques to make part which traditionally was being made by fabrication or moulding technique.

The companies should adapt to this technology due to follwing reasons.

1. It reduces wastage to great extent.
2. It reduces the amount of labour and efforts required to make a product.
3. The chances of error are less.
4. The designs can be directly made by commanding the system.
5. The complex structures can be easily made.
6. The cost in the long run reduces a lot.
7. Innovations are rapidly taking place.
8. The structure of the part remains same throughout.
9. Maintenance required is less.

These are the few reasons because of which the companies should adapt to additive manufacturing.

The few points which need consideration are.

Financial issues.

This technology is till in development and testing phase for large scale utilization so judging it now according to its cost is not correct,once the technology becomes widespread usable then the cost involved will also reduce as more and more people would start using this technology on large scale.

Certifications and regulation.

The government has not completed accepted this technology and thus certification is limited as strength of the object made is considered to be compromised but the present day metal material has shown considerable amount fo improvement and if we consider the airplane parts then the parts are usually made of aluminum alloys and thus they can be easily made through this technique, the issues arise only with hard parts like iron and other hard metals. The technology is rapidly improving and thus certifications will also be available soon.

Repeatability.

Traditional moulding techniques were able to make similar parts quickly and rapidly but additive techniques are not able to do so quickly but the innovations taking place would be able to answer this question as well and thus similar pats would be made rapidly and the present day artificial intelligence an dmachine learning would also add to it.

Skill gap.

The skill gap can be easily handled by training individuals on the new technology and thus a chain of skilled workers can be made easily the technology being simple enough would help to narrow down the gap quickly. The companies can provide free trainings in order to showcase their system and thus the ignorance can be removed easily.

ADDITIVE MANUFACTURING TECHNIQUES -

they are,

* Liquid based additive manufacturing.

APPLICATIONS -

- Low volume production of complex parts.
- Rapid manufacturing.
- Architecture.
- Automotion parts.

* Polymerization.

APPLICATIONS -

- Dental models.
- Jewelry casting.
- Medical application.
- Automotive uses.
- In telecom industries.
- Manufacture rapid tools.

* Binding .

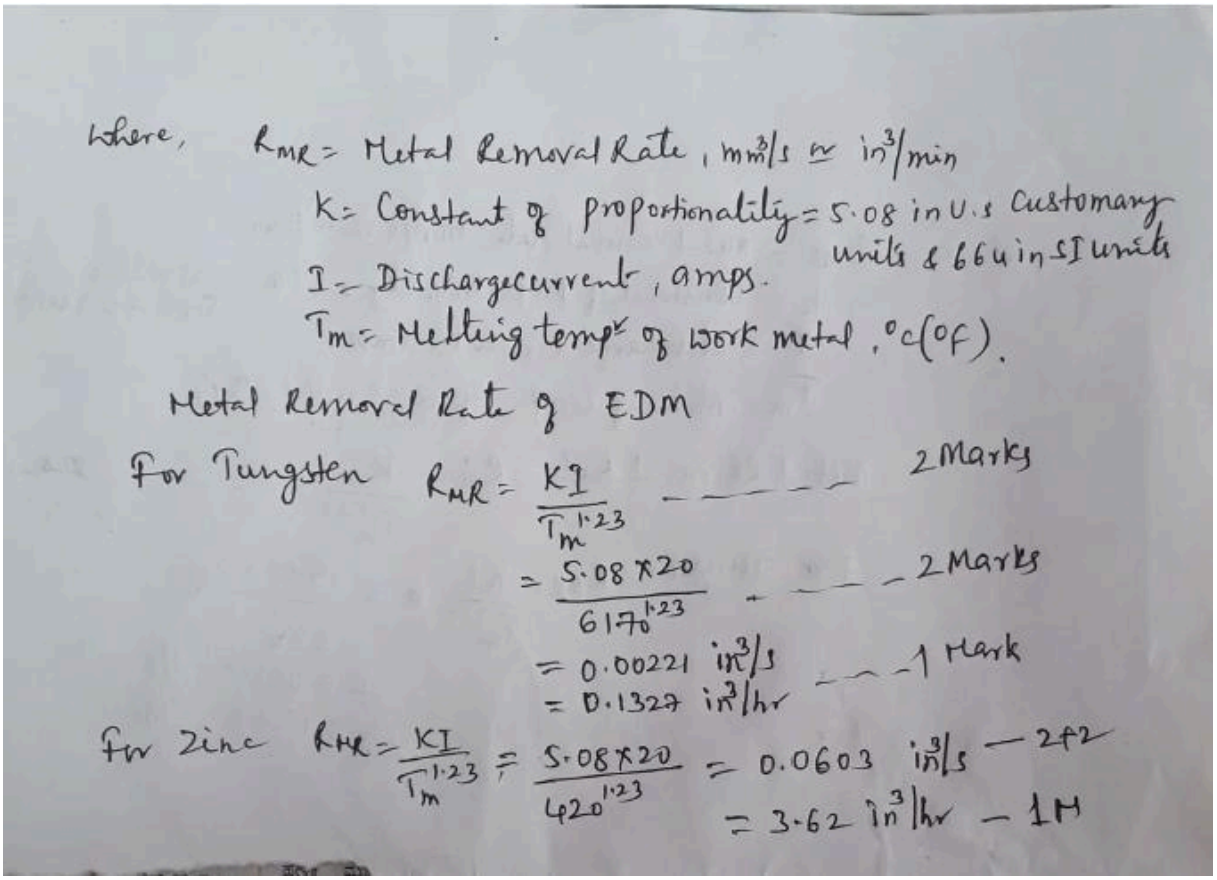
APPLICATIONS-

- Manufacturing of full-colour prototypes.
- Large sand-castimg cores and moldson the plastic/ceramics side and small.
- Functional parts on the metal side.

* Power based additive manufacturing .

4a) An Electric discharge machining operation is being performed on 2 work materials, Tungsten and Zinc. Determine amount of metal removed in the operation after 1 hour at a discharge amperage = 20 Amps for each of these metals. The melting temperatures of tungsten & zinc are 6170^0F & 420^0F respectively.

Ans:

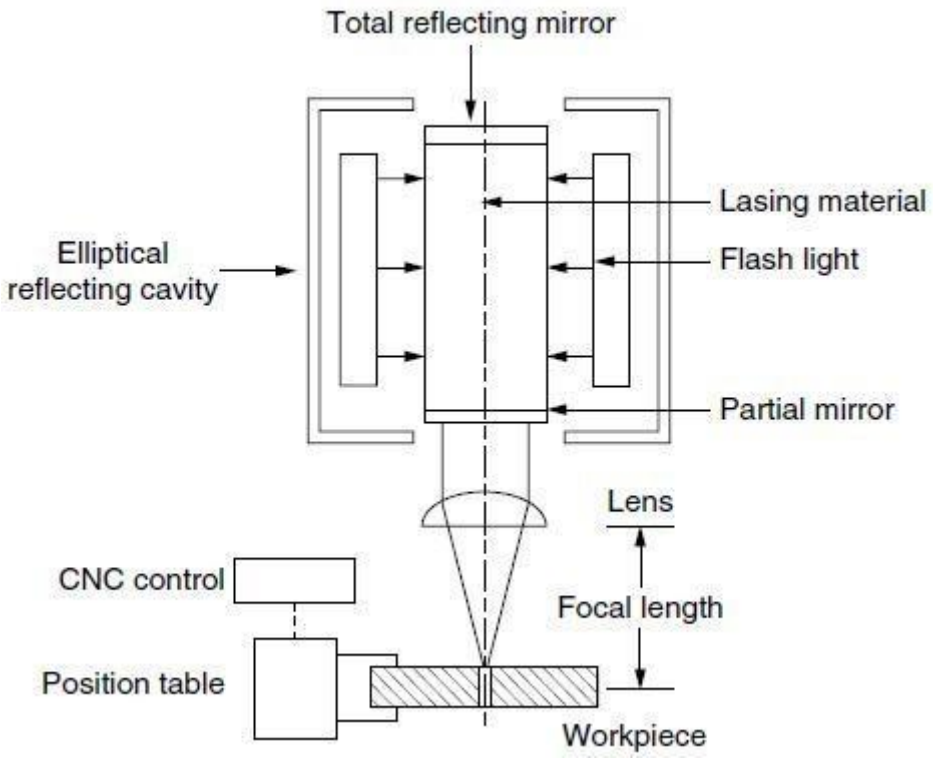


4b) Industrialist needs the engraving of letters on a wood, plastics and rubber materials using LASER. Discuss suitable machining process.

Ans: The machining process which is used in industry for engraving the letters is LASER engraving.

A laser engraving machine is a piece of equipment that performs laser engraving, which is the process of engraving designs, letters or numbers on materials using a laser beam. These machines use automation to achieve precise cuts and engravings on various materials, including metal, wood, glass and plastic

Laser is the abbreviation of light amplification by stimulated emission of radiation. A highly collimated, monochromatic, and coherent light beam is generated and focused to a small spot. High power densities (10^6 W/mm^2) are then obtained. Laser engraving is a process that vaporizes materials into fumes to engrave permanent, deep marks. The laser beam acts as a chisel, incising marks by removing layers from the surface of the material. The laser hits localized areas with massive levels of energy to generate the high heat required for vaporization. The following figure shows the working of LASER.



Five Common Applications of Laser Engraving

- Barcode Creation.
- Decorative or Commemorative Annotations.
- Medical and Electronic Components.
- Signage.
- Awards and Trophies

Advantages of Laser

Engraving:

- Versatile.
- Simple.
- High precision.
- Minimal maintenance.
- Minimal maintenance required

Section-3

5a) The components which are manufactured by Additive Manufacturing (AM) technology known to have various internal defects, such as porosity, internal cracks thermal stresses etc., which can significantly affect the mechanical properties and safety of final parts. Therefore inspection methods are very much important. List different inspection methods adopted in AM. Explain ultrasonic testing and write their advantages.

Ans:

Different inspection methods are

i) Magnetic particle testing

ii) Radiographic Testing
iii) Magnetic particle testing
iv) Ultrasonic testing
v) Electromagnetic Testing
vi) Tube Inspection With Remote Field Testing (RFT)
vii) Remote Visual Inspection (RVI)
viii) Liquid penetrant testing

ultrasonic testing

Ultrasonic testing remains the most popular nondestructive testing method after visual testing. In this method, a high-frequency sound wave generated by a transmitter travels through the object under test. The frequency of this wave is usually between 1 and 10 MHz. The wave distorts when encountering a change in the density of the material. This change in the transmitted wave is captured by a receiver. The equipment then measures and analyses the received wave to understand the nature and depth of the defect. The equipment can also calculate the thickness of the specimen by dividing the wave speed in the material by the time taken for travel. There are many types of ultrasonic testing available each with its own nuances and field of application. These are pulse-echo testing, immersion testing, guided wave testing and phased array ultrasonic testing to name a few. We can identify defects such as cracks, abrasions, thinning, pitting and corrosion using ultrasonic inspection.

Advantages of ultrasonic testing:

1. Quick 2.Clean 3. Reliable 4. Portable 5. Safe and easy to use 6. Highly accurate and sensitive 7. Ability to gauge dense materials 8. Detection of surface and subsurface defects 9. Identifications of minor defects not visible to the naked eye

5b) AM-produced parts are being used many applications. These parts are tested using Non-Destructive testing methods. Suggest the best Non-Destructive testing method used in this case. Present arguments to support your selection.

Ans:

Initial manufacturing process and repair also use NDT. Two of the most significant NDT methods used in aerospace are Magnetic Particle Inspection (MT) and Penetrant testing (PT).

Penetrant Testing –

penetrant inspection, or penetrant testing (PT) , is another method of NDT used in the aerospace industry.

One of the oldest approaches to detect surface flaws like cracks, porosity, gouges, and seams, inspectors add the dye to target areas on a surface.

By capillary action, the dye finds its way into openings, coating the flawed areas. After the excess dye is removed, an additive called the “developer” is introduced, and it draws the remaining dye out.

After a final cleaning step, the dye that penetrated through the developer exposes the critical cracks and porosity in the part when viewed under a black light.

While PT can be used in nearly any NDT application, compatibility of test materials must be considered for the specific industry.

With the inherent severity of chemical incompatibility in the aerospace industry, manufacturers developed classes of penetrants best suited for that industry.

The most common penetrant systems in aerospace are Type I (fluorescent), Methods A, B, and D (water washable, post emulsified – lipophilic, and post emulsified – hydrophilic, respectively).

Benefits of Penetrant testing

i)The method has high sensitivity to small surface discontinuities.

ii) The method has few material limitations, i.e. metallic and nonmetallic, magnetic and nonmagnetic, and conductive and non conductive materials may be inspected.

iii) Large areas and large volumes of parts/materials can be inspected rapidly and at low cost.

iv) Parts with complex geometric shapes are routinely inspected.

v) Aerosol spray cans make penetrant materials very portable.

vi) Penetrant materials and associated equipment are relatively inexpensive.

The balance in the design of aerospace components comes with aiming to lighten the component mass while withstanding the high structural loads on the materials. This high load-to-material strength ratio makes the components susceptible to thermal and pressure cycle fatigue, as well as vibration, due to the wide ranges of operating conditions.

Additionally, corrosion from humidity in the ground air that condenses on the plane attacks the material as well. Over 80% of inspections are performed visually by trained inspectors. Inspectors use NDT for much of the remaining 20% they cannot access visually.

6a) Point out non-destructive testing (NDT) is important ? List the benefits and need of NDT over DT (Destructive testing).

Ans: The importance of non-destructive testing in ensuring that assets are properly maintained cannot be overstated.NDT is an important quality control and quality assurance management tool in industries it may assist in preventing failures that could hurt safety, reliability, and the environment. It is a critical procedure that supports all of their operations. Every equipment piece, product, and material has defined design criteria and expected life. However, because of its faults that may go unnoticed throughout production, fabrication, or service delivery, they may need to undergo substantial repair or be replaced; otherwise, unsafe circumstances or catastrophic failures may result from ignoring their unfit conditions for service.

Benefits of Non-Destructive Testing -

I) The benefits of non-destructive testing are manifold.

II) No damage to the part being tested is sustained and therefore it remains useful.

III) Non-destructive testing can be carried out at any time in the product's lifecycle: raw materials, semi-finished or finished components can be tested with equal measure of effectiveness.

IV) Non-destructive testing also offers very comprehensive testing and can be used to locate both surface and internal flaws.

V) Finally, non-destructive testing allows manufacturers and engineers to ensure worksites and materials are compliant with regulation designed to ensure their safety.

Non-Destructive Testing Needed Because-

Before non-destructive testing was conceived, destructive testing was used to ensure batches of components were manufactured to safety standards.

The logic was that destructive tests should provide an indication about whether a sample of parts was fit to endure the stresses placed on it during operation.

However, despite destructive testing taking place, several incidents occurred where components were destroyed during operation and led to loss of property and human life.

As a consequence, non-destructive testing methods were developed to eliminate such failures without damaging the product in use.

6b) Co-ordinate measuring machine and profile projector are necessity to reach higher standards in industries. Discuss the working principle of CMM.

Ans: Working Principle of CMMs:

Coordinate measuring machines (CMMs) refers to determine the 3D (x y and z) dimensions of objects with the help of probe contacts. The basic principle of CMM is putting the objects which need to be tested in the working range of the system.

It allows you to get the measurement of the object's coordinate either automatically (with the help of software) or with manual configuration. Thanks to software technology which helps in visualizing and analyzation of recorded data.

Then various mathematical calculation techniques are utilized for getting the shape, position tolerance, and other related features of the considered object.

Though advanced coordinate measurement machine provides various other features, however, the dimensional measurement is still the most fundamental application of CMMs. The block diagram of CMM as shown below.

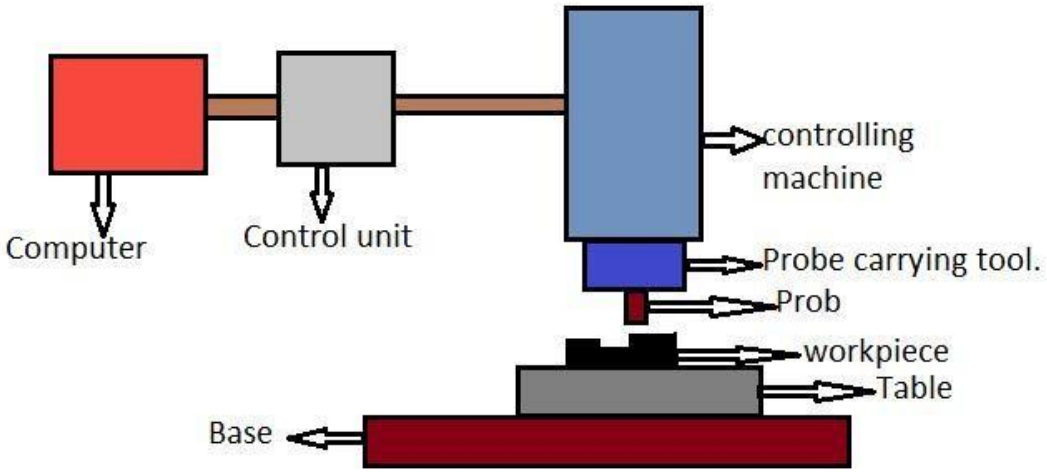


Fig: Coordinate Measuring Machine

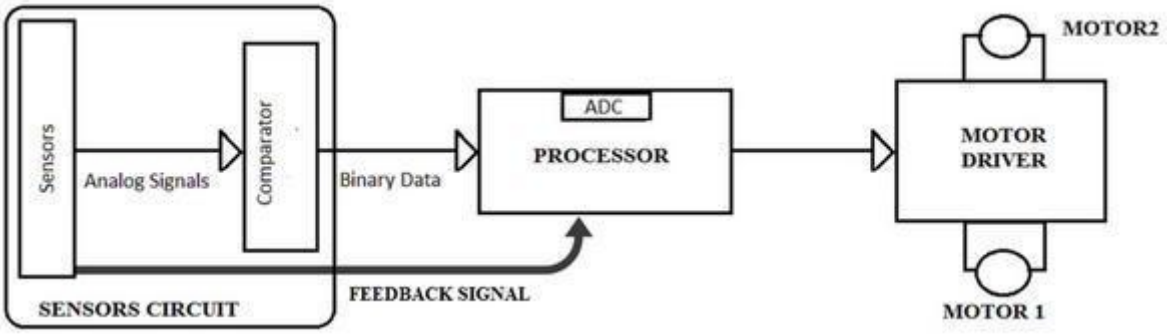
Section-4

7a) Driverless vehicles and navigation systems are improving day after day and are contributing to boost the AGV (Automated guided Vehicle) Market worldwide. Discuss the working principle of AGV.

Ans: Automated guided Vehicle

An AGV is an independently operated vehicle that moves material along defined paths

between defined delivery points or stations. Typically the paths are defined by either using wires embedded in the floor or reflecting paint strips on the floor. The difference of AGV from other electric vehicles is that its operation requires no human input, as it is controlled by a preset program and safety systems and, besides, the vehicle is equipped with additional mechanisms for loading/unloading without human assistance. AGV follows a predetermined path (See the Navigation Principles tab for details). The movement is initiated by a pre-programmed event (beginning of a shift, input of target cargo, operator's command, etc.) . A simple block diagram shows the working principle of AGV.



Working Principle

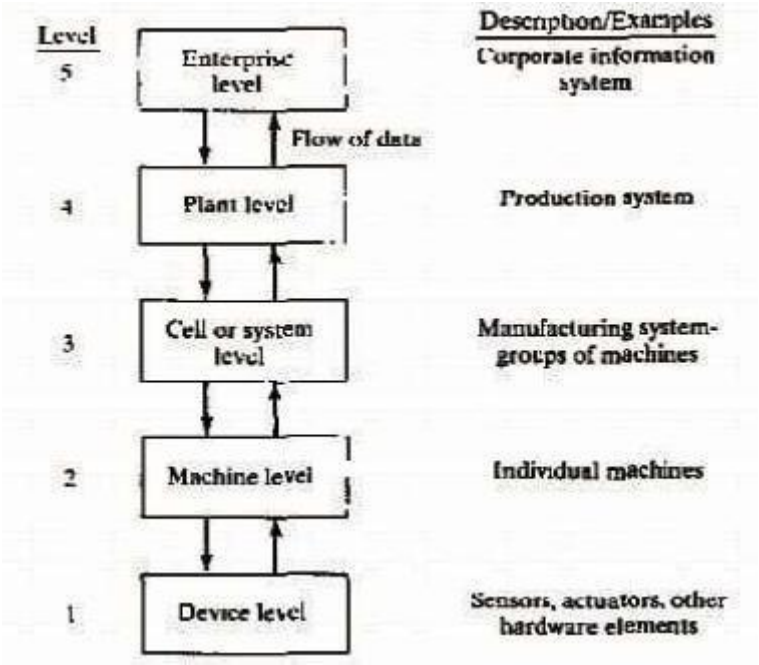
- The working sequence of AGV is as follows:

After receiving the cargo handling instructions, according to the pre-drawn operation map, the current coordinates and the forward direction of AGV. The central controller carries out vector calculation and route analysis, chooses the best driving route, automatically intelligently controls the AGV trolley's driving, turning and steering on the road, arrives at the accurate parking position of loading cargo, and loads the cargo. Then AGV starts to "run" to the target unloading point, stops after arriving at the exact location and completes the unloading, and reports its position and status to the control computer. Then AGV starts to run to the standby area until it receives new instructions and then does the next task. Mircolomay AGV aim to give full play to the maximum effect of AGV. As for consumer, you must have a clear understanding of the internal structure and principle of the product. When choosing an AGV with guaranteed quality. we should also have a thorough understanding and use according to the regulations, so as not to damage the safe operation of the AGV.

Nowadays, AGV(Automated Guided Vehicle) cart has been widely used in the industrial field. It not only solves the first important safety problem in industrial production, but also speeds up the production efficiency.

7b) Discuss the five levels of automation in advanced manufacturing.

Ans:



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 ex· ample, the feedback control loop 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 roo bOIS, 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 arc 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 information 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.

8a) Automated Storage and Retrieval Systems (ASRS or AS/RS) are used in applications where high volumes of inventory move in-and-out of manufacturing or distribution operations. Discuss the working principle of ASRS.

Ans: Automated Storage and Retrieval Systems work by using computer-controlled systems to automatically deposit and retrieve loads from a defined storage area. Automated storage and retrieval systems, sometimes known as ASRS or AS/RS, are made of a variation of computer-controlled systems that automatically place and retrieve loads from set storage locations in a facility with precision, accuracy and speed.

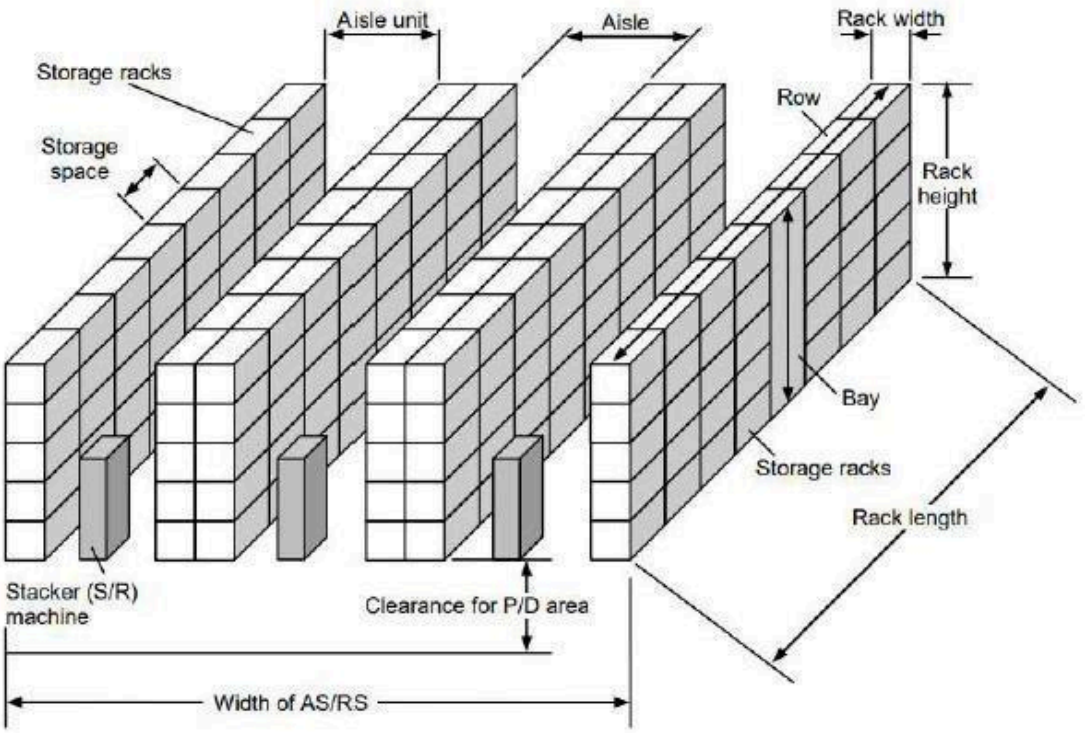
An Automated Storage and Retrieval System (AS/RS) is a combination of equipment and controls that handle, store and retrieve materials as needed with precision, accuracy and speed under a defined degree of automation. Systems vary from smaller automated systems to larger computer controlled storage/retrieval systems totally integrated into a manufacturing and/or distribution process.

Working of AS/RS:

An AS/RS consists of one or more storage aisles that are serviced by a storage/retrieval (S/R)

machine. The stored materials are held by storage racks of aisles. The S/R machines are used to deliver and retrieve materials in and out of inventory. There are one or more

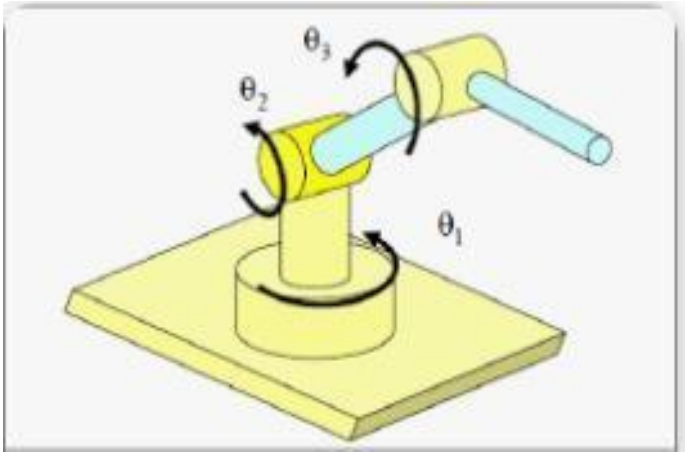
input/output stations in each AS/RS aisle for delivering the material into the storage system or moving it out of the system. In AS/RS terminology, the input/output stations are called pickup-and-deposit (P&D) stations. Generic structure of AS/RS as shown below.



8b) A company requires to setup an articulated robot and cartesian Robots. Discuss how both Robots works.

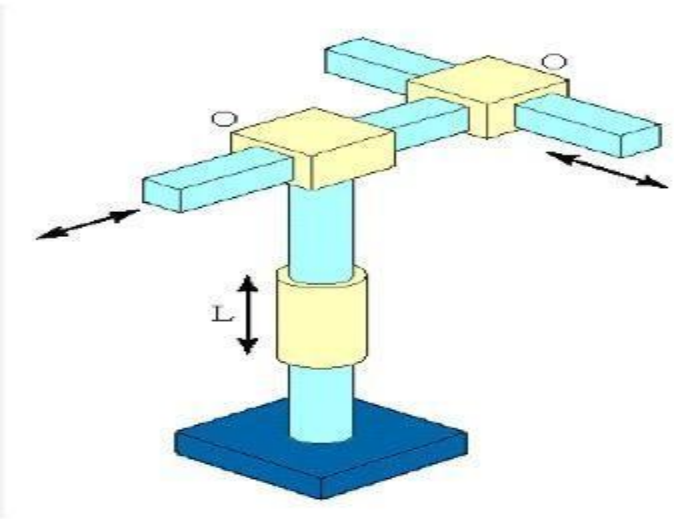
Ans:

Articulated/Revolute Type Configuration: Also called articulated manipulator that looks like an arm with at least three rotary joints. They are used in welding and painting; gantry and conveyor systems move parts in factories.



Cartesian Type Configuration (PPP),(X Y Z)

It is form by 3 prismatic joints, whose axes are coincident with the X, Y and Z planes. These robots move in three directions, in translation, at right angles to each other. Cartesian manipulator is useful for table-top assembly applications and, as gantry robots for transfer of material.



Section-5

9a) Discuss the working of ultrasonic machining process.

Ans: Ultrasonic machining is a mechanical type non-traditiona1 machining process. It is employed to machine hard and brittle materials (both electrically conductive and non-conductive material) having hardness usually greater than 40 HRC.

Working of USM

Ultrasonic machining is a non-conventiona1 machining process in which the removal of hard and brittle materials is done using an axially oscillating tool at ultrasonic frequencies [18—25 kilohertz (kHz)]. As the tool vibrates with a specific frequency, an abrasive slurry (usually a mixture of abrasive grains and water of definite proportion) is made to flow through the tool work interface. There is no direct contact between tool and workpiece. There is gap between tool and workpiece of about 0.25 mm.

The impact force arising out of vibration of the tool and the abrasive particles are, therefore, hammered into the workpiece surface and actually causes thousands of microscopic abrasive grains to remove the work material by abrasion causing chipping of fine particles from it. The oscillating tool of desired shape, at amplitudes ranging from 10 to 50 pm, imposes a static pressure on the

abrasive grains and feeds down as the material is removed to form the required tool shape. Fig. Shows the USM.

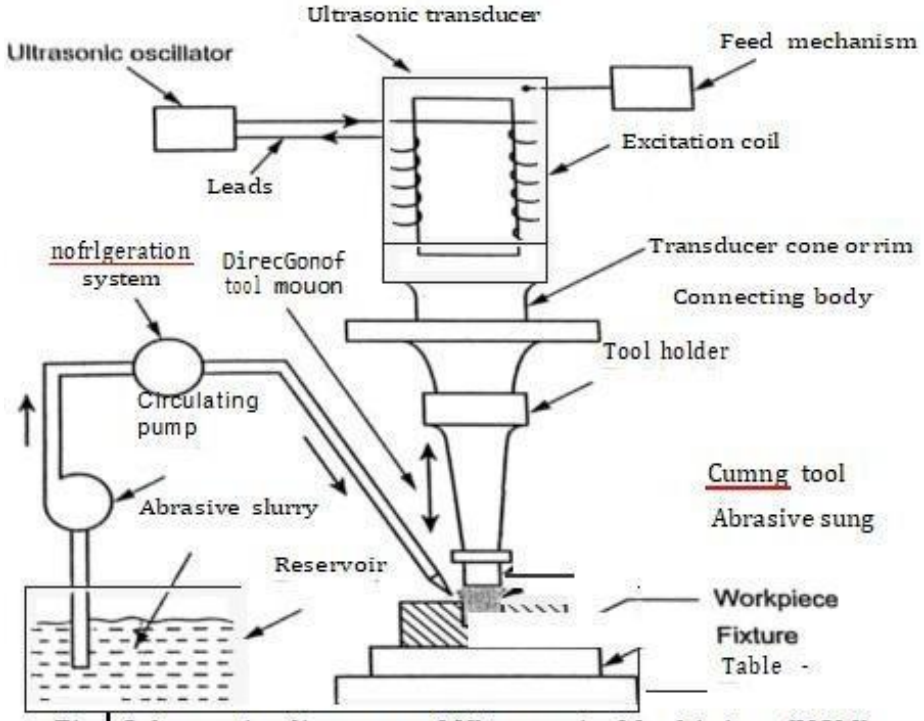


Fig. Schematic diagram of Ultrasonic Machining (USM)

9b) Testing methods use capillary forces to find surface cracks or pores & make them visible. Discuss suitable process and Justify.

Ans : Dye Penetrant Inspection

Principles

DPI is based upon capillary action, where low surface tension fluid penetrates into clean and dry surface-breaking discontinuities. Penetrant may be applied to the test component by dipping, spraying, or brushing. After adequate penetration time has been allowed, the excess penetrant is removed, a developer is applied. The developer helps to draw penetrant out of the flaw where an invisible indication becomes visible to the inspector. Inspection is performed under ultraviolet or white light, depending upon the type of dye used - fluorescent or nonfluorescent (visible).

Inspection steps

1. **Pre-cleaning..**
   The test surface is cleaned to remove any dirt, paint, oil, grease or any loose scale that could either keep penetrant out of a defect, or cause irrelevant or false indications.

2. **Application of Penetrant..**
   The penetrant is then applied to the surface of the item being tested. The penetrant is

allowed "dwell time" to soak into any flaws (generally 5 to 30 minutes). The dwell time mainly depends upon the penetrant being used, material being tested and the size of flaws sought.

3. **Excess Penetrant Removal..**
   The excess penetrant is then removed from the surface. The removal method is controlled by the type of penetrant used.

4. **Application of Developer..**
   After excess penetrant has been removed a white developer is applied to the sample. Several developer types are available, including.. non-aqueous wet developer, dry powder, water suspendable, and water soluble.

5. **Inspection..**
   The inspector will use visible light with adequate intensity (100 foot-candles or 1100 lux is typical) for visible dye penetrant. Ultraviolet (UV-A) radiation of adequate intensity (1,000 micro-watts per centimeter squared is common), along with low ambient light levels (less than 2 foot-candles) for fluorescent penetrant examinations. Inspection of the test surface should take place after 10 to 30 minute development time, depends of product kind.

6. **Post Cleaning..**
   The test surface is often cleaned after inspection and recording of defects, especially if post-inspection coating processes are scheduled.

Justification

Dye Penetrant Inspection (DPI), also called Liquid Penetrant Inspection (LPI) or Penetrant Testing (PT), is one of the oldest and simplists NDT methods where its earliest versions using kerosene and oil mixture). Liquid penetrant inspection is used to detect any surface-connected discontinuities such as cracks from fatigue, quenching, and grinding, as well as fractures, porosity, incomplete fusion, and flaws in joints.

10a) EDM (Electrical discharge machining) has been used in a wide variety of industrial applications ranging from cavity sinking to deburring and ability to machine high strength alloys and hardened steel. Discuss the working of EDM. List the drawbacks.

Ans :

Working of Electrical Discharge Machining (EDM):

Electrical discharge machining works on the principle of metal removal by the combination of electrical and thermal energy. The electrical energy is utilized to create electric spark and heat is produced by erosion of metal.

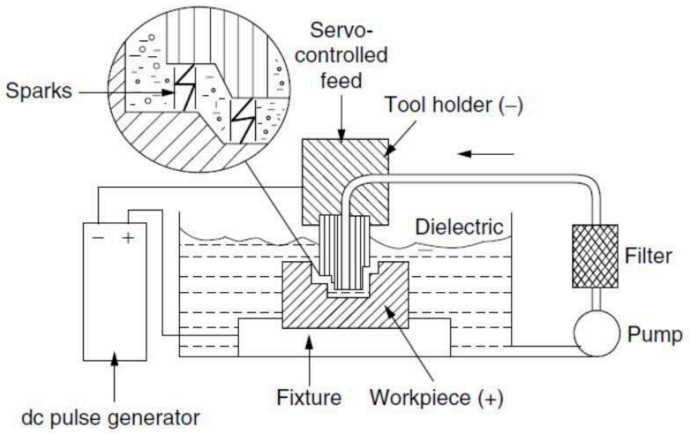


Figure: Working Principle of Electrical Discharge Machining (EDM)

In electro discharge machining, there is no physical contact between tool and workpiece. It is a non-traditional machining process. In this, the tool electrode is connected to the -ve terminal of the DC power supply and workpiece is connected to the +ve terminal of the DC power supply. So, tool acts as a cathode and workpiece acts as an anode.

There is a spark gap between the tool and workpiece is about 0.05 to 0.25 mm. In the flow of dielectric fluid. The dielectric fluid is works as an insulator and as a conductor. When the DC power supply, the tool electrode generated at the spark and due to this the spark hoes to the workpiece by dielectric fluid and machining is done.

In this process, work piece should be well electric conductive. Only electric conductive material can be machined by this method.

OR The working of EDM is as follow.

- First both work piece and tool are submerged into dielectric fluid. The dielectric fluid help to control the arc discharge. This also removes suspended particles of work piece material and tool from the work cavity.
- A servomechanism is used which maintains a very small gap between the work piece and the tool. This gap is desirable for proper arc formation. It is about the thickness of human hair.
- The tool is made as the opposite shape of work piece.
- A high frequency current supplied to electrode, which produces a spark between the tool and work piece. This spark generates high in work cavity.
- The metal removed from the work piece due to erosion and evaporate ion.
- The chips or suspended particle between tool and work piece should be removed to prevent them to form bridge that causes short circuit. This is done by continuous supply of dielectric fluid.
- The EDM produce a cavity slightly larger than the electrode because of overcut

Drawbacks

1. The metal removal rate is slow.
2. Only able to machine conductive materials.
3. Surface cracking may take place in some materials.
4. Reproduction of sharp corners is the limitation of the process

10b) Describe traditional and non-traditional machining processes. List the difference between traditional and non-traditional machining process.

Ans: Traditional Machining process - Traditional Machining process, also termed as conventional machining process which requires the presence of a tool that is harder than the workpiece to be machined.

Non-Traditional Machining - Non-traditional manufacturing processes is defined as a group of processes that remove excess material by various techniques involving mechanical, thermal, electrical or chemical energy or combinations of these energies but do not use a sharp cutting tools as it needs to be used for traditional manufacturing processes.

Differences between Conventional and Non conventional machining processes.

Sl No.	Conventional Process	Non Conventional Process
1.	The cutting tool and work piece are always in physical contact with relative motion with each other, which results in friction and tool wear.	There is no physical contact between the tool and work piece, In some non traditional process tool wear exists.
2.	Material removal rate is limited by mechanical properties of work material.	NTM can machine difficult to cut and hard to cut materials like titanium, ceramics, nimonics, SST,c omposites, semiconducting materials.
3.	Relative motion between the tool and work is typically rotary or reciprocating. Thus the shape of work is limited to circular or flat shapes. In spite of CNC systems, production of 3D surfaces is still a difficult task.	Many NTM are capable of producing complex 3D shapes and cavities.

4.	Machining of small cavities , slits , blind holes or through holes are difficult	Machining of small cavities, slits and Production of non-circular, micro sized, large aspect ratio, shall entry angle holes are easy using NTM
5.	Use relative simple and inexpensive machinery and readily available cutting tools	Non traditional processes requires expensive tools and equipment as well as skilled labour, which increase the production cost significantly
6.	Capital cost and maintenance cost is low	Capital cost and maintenance cost is high
7.	Traditional processes are well established and physics of process is well understood	Mechanics of Material removal of Some of NTM process are still under research
8.	Conventional process mostly uses mechanical energy	Most NTM uses energy in direct form For example : laser, Electron beam in its direct forms are used in LBM and EBM respectively
9.	Surface finish and tolerances are limited by machining inaccuracies	High surface finish(up to 0.1 micron) and tolerances (25 Microns)can be achieved
10.	High metal removal rate.	Low material removal rate.

This is to certify that, the model answers prepared by me for the code 20ME53IT are from the prescribed reference text book and model answers and scheme of valuation prepared be me are correct to to the best of my knowledge.