



WINTER – 2022 EXAMINATION
Model Answer

Subject Name: Advanced Manufacturing Process

Subject Code:

22563

Important Instructions to examiners:

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.
- 8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1	a	<i>Advantages of Electro- Discharge Machining process</i> 1) Process can be applied to all electrically conductive metals and alloys. 2) Any complicated shape that can be made on the tool can be reproduces on the workpiece. 3) Can be employed to extremely hardened material. 4) No mechanical stress is present in the process. 5) Hard and corrosion resistant surfaces essentially needed for die making can be developed. 6) The process leaves a non-directional surface finish. The surface consists of tiny craters with no definite pattern or lay. (craters accommodate lubricants causing the die life to improve)	01 mark each any two

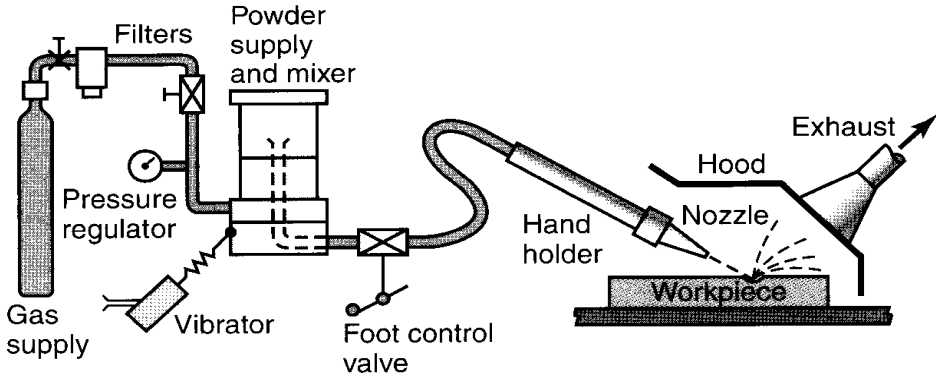


b	<p>Types of Milling Machines:</p> <p>Knee and Column type</p> <p>a. Horizontal.</p> <p>b. Vertical</p> <p>c. Universal</p> <p>d. Turret Type</p> <p>Production Type</p> <p>a. Simplex</p> <p>b. Duplex</p> <p>c. Triplex</p> <p>Special Type</p> <p>a. Rotary table</p> <p>b. Drum type</p> <p>c. Copy milling</p> <p>d. Planetary milling machine.</p> <p>Planner Type milling</p>	1/2 mark each any four
c	<p>Gear Manufacturing Methods:</p> <p>Casting</p> <p>Forging</p> <p>Extrusion and cold-drawing</p> <p>Powder metallurgy</p> <p>Blanking</p> <p>Gear Machining</p> <ul style="list-style-type: none">- Hobbing- Shaping- Milling- Broaching	01 mark each any two



d	<p>Functions of CNC machine components:</p> <p>1) Machine Control Panel – A machine Control Panel is a flat area where controlling, monitoring, or managing instruments are displayed, serving as the direct interface between the operator and the NC system.</p> <p>2) Programmable Logic Controller (PLC) – A PLC is an industrial solid-state computer that matches the NC to the machine, which follows a pre-programmed sets of rules and carry out outputs based on inputs to control system and make logic-based decisions for the CNC machine. It is used to minimize manual operation and can survive harsh conditions such as extreme heat, cold, dust, and moisture.</p> <p>3) Servo Control Unit – The servo control unit is responsible for precise position control as it receives the position feedback signals for the actual movement of the machine tool axes from the feedback devices. It generates suitable signals as command values, which are interfaced with the axes and the spindle motors.</p> <p>4) Feedback Devices – The feedback devices, which is also referred to as the measuring system, consist of position and speed transducers that act as sensors to monitor the current position of the cutting tool at any instant.</p> <p>5) Display Unit – The display unit is a monitor or an interactive device between the machine and the operator which displays the present status of the programs, commands, and other necessary data of the CNC machine. It can also be useful for maintenance and installation work because it can display other important information such as machine parameters, logic diagram of the program controller, error messages, and diagnostic data.</p> <p>6) Machine Tool- Machine tool element of an CNC system is the equipment that processes the work piece</p> <p>7) Program of instruction- the part program is called as program of instruction. It is the detail step by step set of instruction which tells the machine tool what to do.</p>	01 mark each any two
e	<p>Meaning of CNC code M03 & M06</p> <p>M03:- Starts the spindle CLOCKWISE.</p> <p>M06: Tool change command</p>	01 mark each
f	<p>Home Position:</p> <p>Machine homing gives a reference position of each axis, this position is used to allow for job fixtures, jigs, and automatic tool changer. Each CNC machine has a built-in location that is called machine zero.</p> <p>All three axes are moved to extreme positive locations until limit switches are reached.</p> <p>Once the sensor is tripped, the control software sets a zero position for that axis.</p> <p>Programme Zero :</p> <p>Each part program sets a starting location called program zero. Unlike machine zero, the programmer selects the program zero for each work piece. This location acts as the origin from which all the other dimensions are calculated during the program and it is usually located on the edge of a work piece.</p>	01 mark each



g	<p>Automation generally is defined as the process of enabling machines to follow a predetermined sequence of operations with little or no human intervention and using specialized equipment and devices that perform and control manufacturing processes and operations.</p> <p>Example: In hard automation, or fixed-position automation, the machines are designed to produce a standard product, such as a gear, a shaft, or an engine block.</p> <p>1) Automotive engines 2) Mechanized assembly 3) Machining transfer lines 4) Automated material handling.</p>	01 mark for definition, 01 mark for example
2	Attempt any THREE of the following	
a	<p>Working of Abrasive Jet Machining:</p>  <p>In abrasive-jet machining (AJM), a high-velocity jet of dry air, nitrogen, or carbon dioxide containing abrasive particles is aimed at the workpiece surface under controlled conditions. The impact of the particles develops a sufficiently concentrated force to perform operations. The gas-supply pressure is on the order of 850 kPa, and the abrasive-jet velocity can be as high as 300 m/s and is controlled by a valve. The nozzles are usually made of tungsten carbide or sapphire, both of which have abrasive wear resistance. The abrasive size is in the range from 10 to 50 μm.</p>	02 marks sketch, 02 marks explanation

b **Column and Knee Type of Milling Machine**

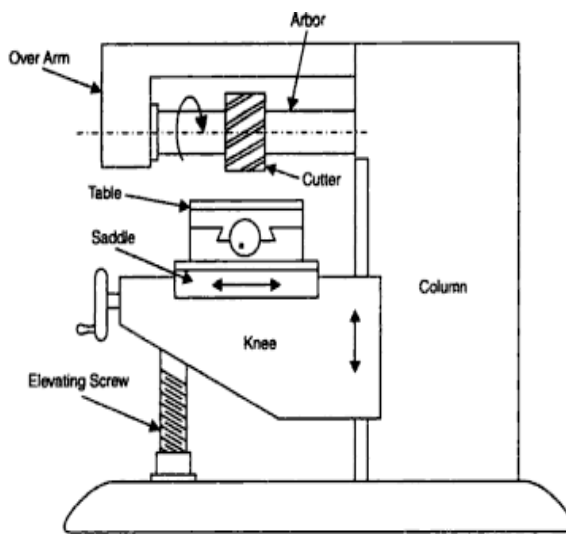


Fig. 8.1(a) Horizontal Milling Machine

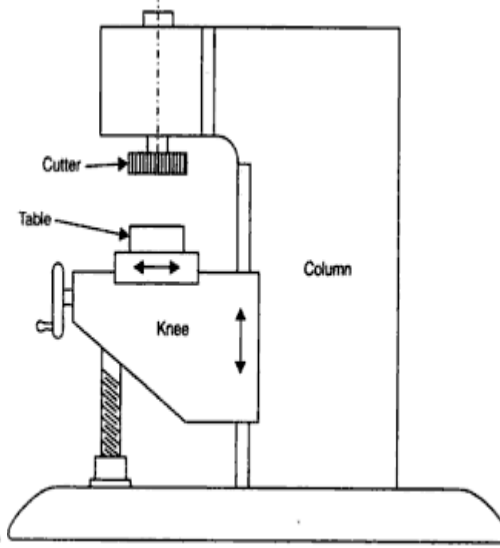


Fig. 8.2(a) Vertical Milling Machine

02 marks for sketch (any 1 type of machine) 02 marks for functions (1/2 mark each any 4 parts)

Column and base: Column including base is the main casting that supports all other parts of milling machine.

Knee: It consists of a table feed mechanism and various controls. A knee is used to support saddles, work tables, and workpiece clamping devices.

Saddle: The top of the saddle is machined in precision to provide guideways for the table.

Work Table: A work table is the most important part of a milling machine on which the workpiece or a job holds tightly and performs many operations.

Spindle: The spindle is located at the top of the column and rotates through receives power from belts, gears, and clutches and transmits it to the arbor.

Overarm: It is mounted at the top of the column and rises in front of the column face. It is commonly used to support arbor and spindle.

Arbor: It is the extension parts of spindles on which milling cutters are held or rotated.

c **Cutter radius Compensation :**

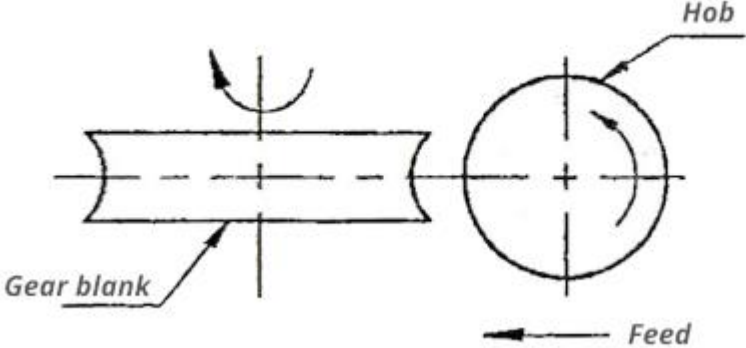
Cutter compensation is used to offset the center of the cutter, and shift it the distance of the radius, to the specified side of the programmed path.

Complex part geometries having angled lines, lines tangent to arcs, and lines intersecting arcs involve substantial trigonometric computations to determine the center of the cutter.

Cutter compensation involves programming the part geometry directly instead of the tool center. The cutter compensation commands are Cutter Comp. Left (G41), Cutter Comp Right (G42) and Cutter Comp Cancel (G40).

02 marks for explanation, 02 marks for example



d	<p>CNC machine simulation provides following features:</p> <ol style="list-style-type: none">1. View and proof cut paths from any angle2. Set machine travel limits and detect over travels3. Check for part errors – including machine, tool, and tool holder collisions4. Utilize you machine’s kinematics to visually see your machine tool in action5. See exactly how the part will look cut on your machine at any point during the machining process in a virtual environment6. Set up an unlimited amount of virtual machines that match the machines in your shop7. Assign transparency levels of the simulated machines for enhanced part viewing ability8. Accurately calculate cycle times9. Use dynamic viewing functionality for better inspections10. Identify machine-part deviations to know where tools were unable to machine within the associated operations.	04 marks for correct answer
3	Attempt any THREE of the following	
a	<p>Gear Hobbing process</p> <ul style="list-style-type: none">• Hobbing is a process of generating a gear by means of cutter called Hob, which revolves & cuts like milling cutter.• There are three types of gear hobbing according to the direction of feeding the hob as, Axial hobbing Radial hobbing Tangential hobbing <p>Radial hobbing</p>  <ul style="list-style-type: none">• In radial hobbing the feed is given to the hob such that it moves radially towards the centre of blank.• Radial feeding is suitable for cutting worm wheels having a helix angle of less than 6 or 7 degrees.• Radial feed stops when the hob reaches the full depth of cut.• Radial hobbing may affect the accuracy of tooth profile of final cut gear.	02 marks for sketch, 02 marks for explanation



b	<p style="text-align: center;">Compare CNC & DNC machines</p> <table border="1" style="width: 100%;"><thead><tr><th style="width: 50%; text-align: center;">CNC</th><th style="width: 50%; text-align: center;">DNC</th></tr></thead><tbody><tr><td>CNC is transferring machine instruction.</td><td>DNC controls the information distribution to a wide variety of machines</td></tr><tr><td>In the CNC program feeds directly into the computer by a small keyboard similar to our traditional keyboard</td><td>DNC part program is feed to the machine through the main computer.</td></tr><tr><td>Using CNC PC manipulates one NC machine</td><td>Using the DNC programmer can manage more than one NC laptop as required</td></tr><tr><td>CNC has low processing power when compared to DNC</td><td>DNC has high processing energy when compared to CNC.</td></tr><tr><td>It has memory storage ability in which part program can be store</td><td>Same part program can be run on different machines at the same time</td></tr><tr><td>System can import CAD files and convert it to part program</td><td>The data can be processed using the MIS software so as to effectively carry out the production planning and scheduling</td></tr><tr><td>CNC machine maintenance is high</td><td>Maintenance is low in DNC machines.</td></tr></tbody></table>	CNC	DNC	CNC is transferring machine instruction.	DNC controls the information distribution to a wide variety of machines	In the CNC program feeds directly into the computer by a small keyboard similar to our traditional keyboard	DNC part program is feed to the machine through the main computer.	Using CNC PC manipulates one NC machine	Using the DNC programmer can manage more than one NC laptop as required	CNC has low processing power when compared to DNC	DNC has high processing energy when compared to CNC.	It has memory storage ability in which part program can be store	Same part program can be run on different machines at the same time	System can import CAD files and convert it to part program	The data can be processed using the MIS software so as to effectively carry out the production planning and scheduling	CNC machine maintenance is high	Maintenance is low in DNC machines.	01 mark each any four points
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c	<p>Preparatory function of CNC</p> <ul style="list-style-type: none">• It is representing by 2 digit number prefixed by the letter G.• The purpose of preparatory function is to command the machine tool to perform the function represented by the selected code number.• ISO has standardized a number of these preparatory function.• Ex.G90 specifies absolute input dimension. <p>Miscellaneous function of CNC</p> <ul style="list-style-type: none">• This function involves actions that are necessary for machining.• These are used to designate a particular mode of operation for a CNC machine tool.• They are not related to actual machining but execute auxiliary functions like start/stop of spindle, ON/OFF coolant, etc.• A miscellaneous function of CNC is represented by letter M.	02 marks each																
d	<p>Pneumatic actuators are widely used in Robotics</p> <p>As pneumatic actuators fulfil all necessary requirements of Robotics like-</p> <ul style="list-style-type: none">• It converts energy formed by compressed air at high pressure into either linear or rotary motion.• It gives quickly respond in operation which is necessary in Robotics.• Pneumatic cylinders provide more force & speed per unit size than any other actuator.• Force speed of pneumatic actuator is easily adjustable & is independent of each other.• It is most economical when the scale of deployment matches the capacity of the compressor.• Cost of pneumatic actuator is less as compared to other actuators.	04 marks for correct explanation																



4		Attempt any THREE of the following																				
	a	<table border="1"><thead><tr><th>Gear Hobbing</th><th>Gear Shaping</th></tr></thead><tbody><tr><td>It use as multipoint cutter Know as Hob.</td><td>It uses a rack cutter or pinion cutter.</td></tr><tr><td>Generates teeth on gear by means of Rotating cutter called as Hob.</td><td>Reciprocating motion of the cutter based on Shaping process.</td></tr><tr><td>It cannot generate internal gear</td><td>It can be used to produce internal gears also</td></tr><tr><td>The tooth profile error level is higher.</td><td>The tooth profile error level is lower.</td></tr><tr><td>Gear hobbing process is less precise than gear shaping process.</td><td>Gear shaping process is more precise than gear hobbing process.</td></tr><tr><td>It provides less accuracy in surface finish than gear shaping.</td><td>It provides more accuracy in surface finish than gear hobbing.</td></tr><tr><td>The transmission chain used in mechanical gear hobbing is less complex.</td><td>The transmission chain used in mechanical gear shaping is more complex.</td></tr><tr><td>It is rapid, economical and highly Productive.</td><td>It required more time than hobbing.</td></tr></tbody></table>	Gear Hobbing	Gear Shaping	It use as multipoint cutter Know as Hob.	It uses a rack cutter or pinion cutter.	Generates teeth on gear by means of Rotating cutter called as Hob.	Reciprocating motion of the cutter based on Shaping process.	It cannot generate internal gear	It can be used to produce internal gears also	The tooth profile error level is higher.	The tooth profile error level is lower.	Gear hobbing process is less precise than gear shaping process.	Gear shaping process is more precise than gear hobbing process.	It provides less accuracy in surface finish than gear shaping.	It provides more accuracy in surface finish than gear hobbing.	The transmission chain used in mechanical gear hobbing is less complex.	The transmission chain used in mechanical gear shaping is more complex.	It is rapid, economical and highly Productive.	It required more time than hobbing.		01 mark each any four points
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	b	<p>Working & Importance of Re-circulating ball screw used in CNC machine</p> <ul style="list-style-type: none">• It is the mechanical component increasingly used in movement transmission, used to transform a rotary motion into translation motion in CNC machines.• It is precise & provides superior performances in CNC machine.• Between the threaded shaft & nut screw are inserted steel balls which have task to transform the sliding friction into rolling friction. <p>Importance</p> <ul style="list-style-type: none">• It provides high efficiency & durability to CNC machine.• It improves wear resistance.• It reduces friction between parts in contact.• It reduces backlash.• X-Y recorders of CNC machine.• It used in power actuators.		02 marks for working, 02 marks for importance																		



C

04 marks

Given Data:

$V = 90 \text{ m/min}$, $f = 0.2 \text{ mm/rev}$, $D = 60 \text{ mm}$
Depth of cut, $d_c = 5 \text{ mm}$, length of cut, $l = 120 \text{ mm}$

Cutting Parameters:

$$\text{Spindle Speed: } V = \frac{\pi DN}{1000}$$

$$N = 478 \text{ rpm}$$

$$\text{Feed: } f = 0.2 \text{ mm/rev.}$$

$$\text{Depth of cut: } d_c = 5 \text{ mm}$$

Part Name :- 2.4(c)
Part Material :- Aluminium
Part No. :- Fig.No. 1

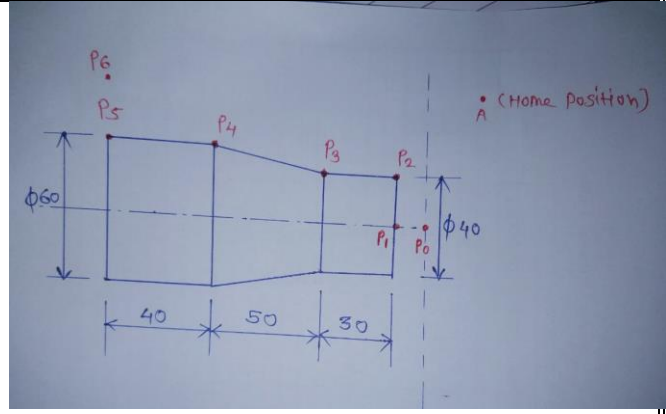
Name of operator :-
Name of Machine :-
Part Size :- Dia. 60

Operation No.	Description	Machine Tool	Tool/Fixture	Spindle Speed (rpm)
1	Clamp the blank in chuck	centre lathe	3 jaw chuck	
2	Facing operation	centre lathe	single point cutting tool	478
3	Turning	centre lathe	single point cutting tool	478
4	Unloading Job		Chuck key	



d

Tool Position	Co – ordinate	
	X	Z
P0	0	5
P1	0	0
P2	40	0
P3	40	-30
P4	60	-80
P5	60	-120
P6	70	-120



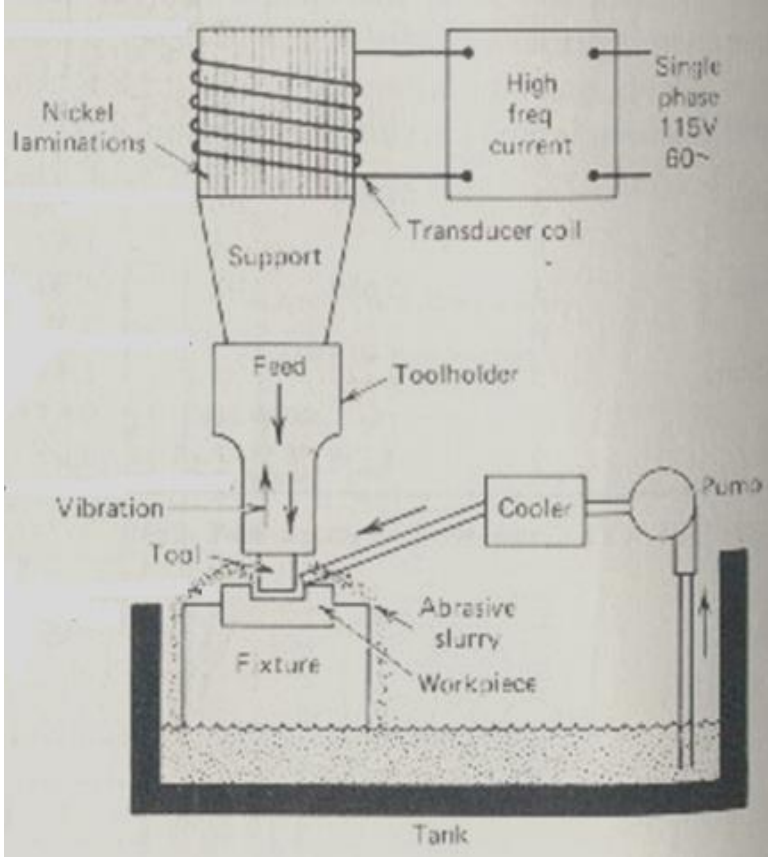
Tool path A- P0- P1-P2-P3-P4-P5-P6-A

O0001	Program Number
N100 G28 U0 W0 ;	Machine Referance position
N110 G90 G21 G95 ;	Absolute mode , input in mm , Feed mm/rev.
N120 M06 T01 ;	Select Tool T01
N130 M03 S1500 ;	Spindle on, Spindle speed
N140 M08 ;	Coolant on
N150 G00 X0 Z5 ;	Rapid positining tool @ position P0
N 160 G01 X 0 Z0 F0.2;	Linear interpolation ,feed ,tool @ postion P1
N 170 G01 X 40 Z0 F0.2;	Linear interpolation ,feed ,tool @ postion P2
N 180 G01 X 40 Z-30 F0.2;	Linear interpolation ,feed ,tool @ postion P3
N 190 G01 X 60 Z -80 F 0.2 ;	Linear interpolation ,feed ,tool @ postion P4 (Taper turning operation)
N 200 G01 X 60 Z-120 F0.2;	Linear interpolation ,feed ,tool @ postion P5
N 210 G00 X70 Z -120 ;	Rapid positining tool @ position P6
N 220 G28 U0 W0 ;	Machine Referance position
N 230 M05 ;	Spindle Off
N 240 M09	Coolant Off
N 250 M30	Program end and tape revind

04 marks



e	<p>Cellular manufacturing</p> <p>It is one of the main tools of Lean Manufacturing, helps to create a concept known as single or one-piece flow.</p> <p>Equipment and the workstations are arranged in sequences to allow for a smooth flow of materials and components through the process.</p> <p>The cell is made up of workers and the equipment required performing the steps in creating the product. The layout of the equipment and the workstations is determined by the logical sequence of production.</p> <p>By grouping similar products into families that can then be processed on the same equipment in the same sequence, cellular manufacturing offers companies the flexibility to give customers the variety they require.</p> <p>Factories converted to cellular manufacturing benefit by the reduction of overproduction and waste, shorter lead time, improved quality and productivity, improved teamwork and communication.</p> <p>The main requirement of Cellular Manufacturing is to ensure that all equipment required for production is operating at 100% efficiency at all times.</p> <p>Through short daily inspections, cleaning, lubricating, and making minor adjustments, minor problems can be detected and corrected before they become a major problem that can shut down a production line.</p> <p>The basic concept of cellular manufacturing is the integration of management practices with technological advances. To be truly successful requires a thorough understanding of the causes and elimination of waste at all levels, and that means both operations and processes.</p> <p>There are several important considerations involved in order to achieve the best benefits:</p> <ul style="list-style-type: none">• Reduction of lead time• Utilization of available space• Maximizing flexibility• Emphasizing teamwork• Improving communications• Productivity and quality improvement	04 marks for explanati on
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5	<p>Attempt any TWO of the following</p>	
a	<p>Ultrasonic Machining:-</p>  <p>High power sine wave generator This unit converts low frequency (60 Hz) electrical power to high frequency (20kHz) electrical power.</p> <p>Transducer The high frequency electrical signal is transmitted to traducer which converts it into high frequency low amplitude vibration. Transducer converts electrical energy to mechanical vibration.</p> <p>Tool holder. OR Horn. The tool holder holds and connects the tool to the transducer</p> <p>Tool Tools are made of relatively ductile materials like Brass, Stainless steel or Mild steel so that Tool wear rate (TWR) can be minimized.</p>	<p>03 marks for sketch, 03 marks for functions (any three 01 marks each)</p>



b

Q. 5 (b)

Given Data:-

Cutter diameter $d = 10 \text{ mm}$

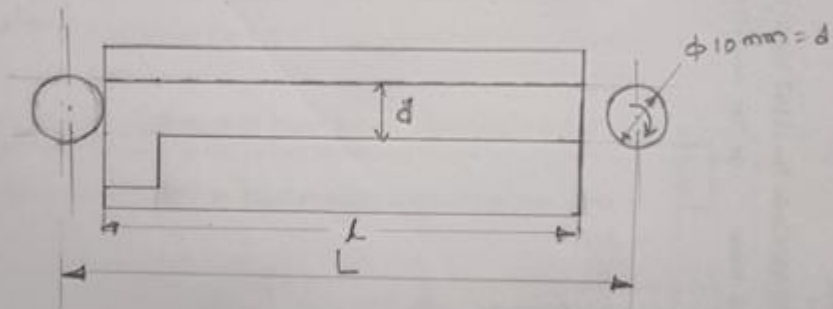
$n = 1000 \text{ rpm}$

$v = ?$

$$v = \frac{\pi d n}{1000} \quad \text{----- 1 m}$$

$$\therefore v = \frac{\pi \times 10 \times 1000}{1000} \quad \text{----- 1 m}$$

$$\therefore v = 31.41 \text{ m/min} \quad \text{----- 2 m}$$



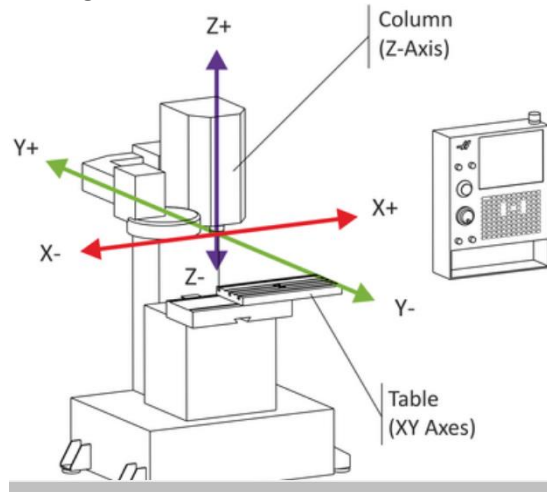
End milling operation ----- 2 m

c

Axes Nomenclature in CNC machine

CNC Milling Center:-

In CNC milling center (CNC vertical machining center), the workpiece is held on the table base and the spindle which contains the cutting tool is fixed on vertical spindle Z axis. The table moves in X and Y axis and spindle with cutting tool moves in Z axis.



CNC Turning Center:-

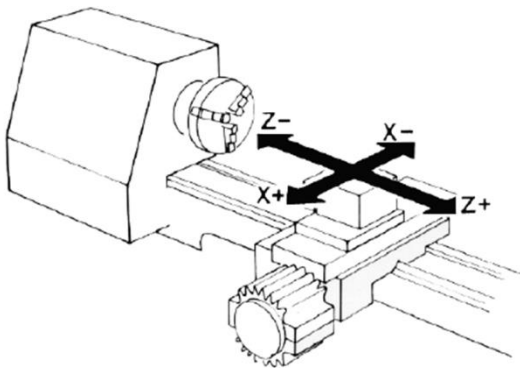
X- in horizontal direction

Z – perpendicular to both axis

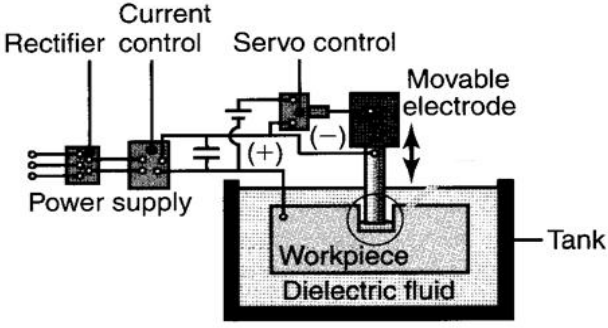
Z axis defines the tool movement

i.e tool movement towards work piece Z negative (Z –ve)

and away from the workpiece Z positive (Z + ve)



03 marks
each (01
mark for
sketch,
02 marks
for axis)

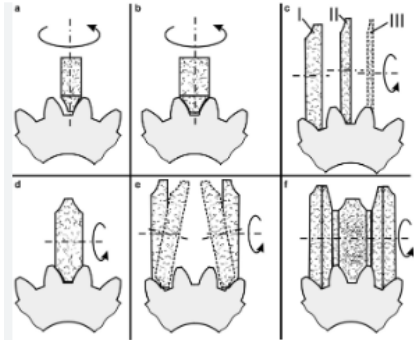
6	Attempt any TWO of the following		
a	 <p>Discharge Current Range: The capacitor discharge is repeated at rates between 200 and 500 kHz, with currents from 0.1 to 500 A.</p> <p>Voltage Range: voltages usually ranging between 50 and 380 V.</p> <p>Type of Dielectric: The most common dielectric fluids are mineral oils, although kerosene and distilled and deionized water also are used in specialized applications.</p> <p>Type of Electrode material: Electrodes for EDM usually are made of graphite, although brass, copper, or copper-tungsten alloys, Tungsten-wire electrodes also are used.</p>	02 marks for sketch, 04 marks for parameter ranges (01 mark each)	
b	<p>Q. 6 (b)</p> <p>Simple (Plain) indexing method for indexing 30 divisions.</p> <p>$N = 30$</p> <p>Index crank movement = $\frac{40}{N}$ ----- 1 m</p> <p>$= \frac{40}{30} = 1 \frac{1}{3}$ ----- 1 m</p> <p>$= 1 \frac{1}{3} \times \frac{7}{7}$ ----- 1 m</p> <p>$= 1 \frac{7}{21}$ ----- 2 m</p> <p>∴ For indexing one complete turn and 7 holes in 21 hole circle of the index plate using Plate no. 2 ----- 1 m</p>		

c

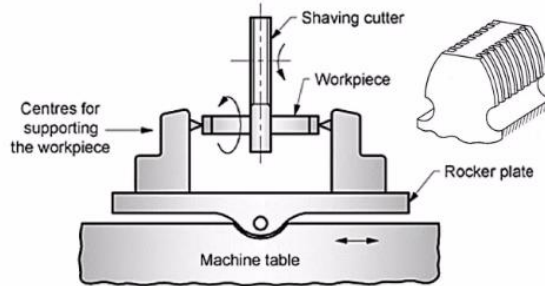
Need for Gear Finishing:

- To improve the accuracy
- To achieve uniformity of gear tooth element
- To achieve quiet operation at high speeds and to transmit heavy loads with better life.
- To remove heat treatment distortions

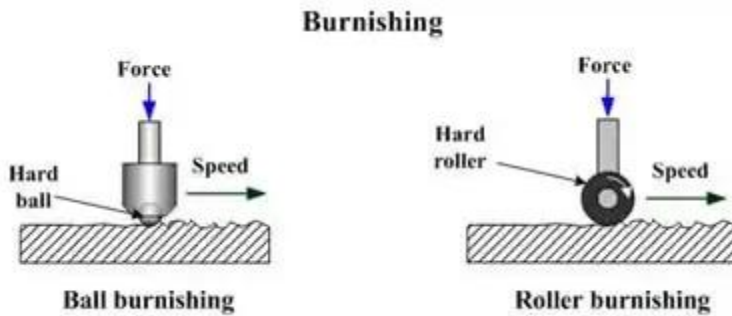
Gear Grinding



Gear Shaving



Gear Burnishing



Process parameters:-

- 1) Workpiece material
- 2) Type of gear
- 3) Whether the gears have been hardened by heat treatment or not.
- 4) Dimensional accuracy required.
- 5) Surface quality of the gears.

02 marks for need, 02 marks for sketch (any one), 02 marks for process parameters (any two)