Advanced Manufacturing Processes
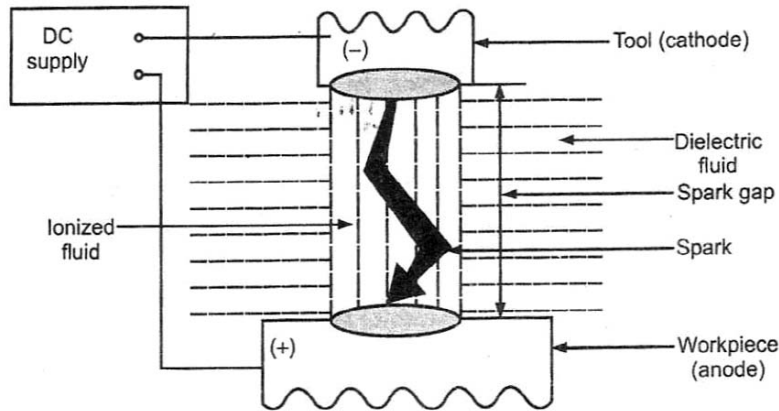
Q.1(a) Attempt any THREE of the following: [12]
Q.1(a) (i) Explain the principle of EDM with neat sketch. Give two applications of EDM.   [4]
Ans.:

- EDM is electrical discharge machining. It is also known as spark erosion or simply spark machining.
- It is process of metal removal, based on the principle of erosion of metals by an interrupted electric spark discharge between the electrode tool (usually cathode) and the work (anode).
- In this process, both the tool and workpiece are immersed in dielectric fluid.
- The work is connected to +ve terminal and tool is connected to −ve terminal.
- The tool end is brought near the workpiece by a servo motor. A small gap of about 0.01 to 0.5 mm is maintained in between tool and workpiece.
- When a difference of potential is applied between two conductors, the dielectric fluid will ionize.
- The potential difference reaches a high, spark will occur. The repetitive spark release their energy in the form of Local heat and metal is melted and eroded.

Application:
1. For producing very small holes (as small as 0.1 mm dia.)
2. Embossing, engraving operation on harder materials and for making holes in nozzles.
3. Internal threads and internal gears can be produced in harder material.
4. Shaping Tungsten carbide dies, press tools and to give any intricate shape.

Q.1(a)(ii) Classify indexing methods in gear cutting.   [4]
Ans.:   Indexing methods in gear cutting are classified into four types :
- Direct or Rapid indexing
- Simple or Plain indexing
- Compound indexing
- Differential indexing

Q.1(a)(iii) State four needs of non-traditional machining processes.   [4]
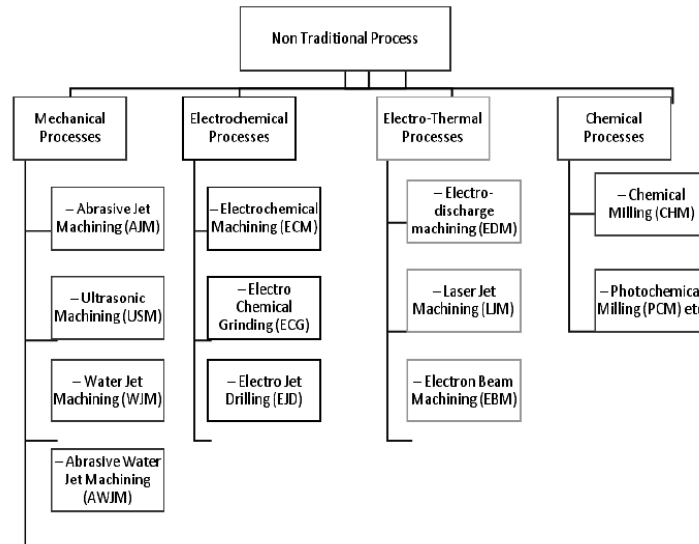**Ans.:   Needs of non traditional machining processes are :**
Traditional machining processes are not suitable for machining greater hardness ,high strength, heat resistant alloys. The following are the reasons for the need of the non traditional machining process.
1. To machining High Strength ,heat resistant Alloys.

2. To produce desired intricate shapes and components like dies, molds, long holes of small sizes and, machining complex surfaces.
3. To obtained High accuracy and high degree of surface finish.
4. To machining new innovative materials like exotic materials due to technology advancement.
5. To manufacture innovative geometric design products and processes.

Q.1(a)(iv) How are nontraditional machining processes classified? State its importance.   [4]
**Ans.:   Classification of non–traditional machining processes**

Importance of Nontraditional Machining process.
1. Material removal may occure with chip formation or even no chip formation may take place.
2. In NTM, there may not be a physical tool present.
3. In NTM, the tool need not be harder than the work piece material.
4. Mostly NTM processes do not necessarily use mechanical energy to provide material removal.
5. They use different energy domains to provide machining.

Q.1(b) Attempt any ONE of the following: [6]
Q.1(b)(i) Draw neat labelled sketch of centerless grinding. Explain its working.   [6]
**Ans.:**
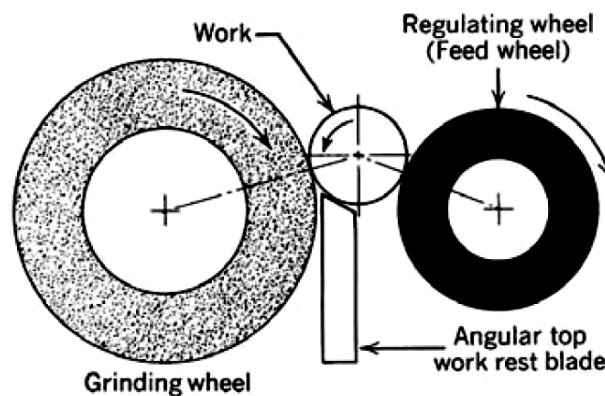
In this process the job/work piece is supported between grinding wheel, regulating wheel & work rest blade. Center less grinding operation is performed by grinding wheel only while regulating wheel provides support to work piece while it is pushed away by grinding pressure of grinding wheel. The direction of rotation both wheels are the same. External & Internal

grinding can be done on center less grinding machine. The common methods used for feeding the work are

(i) Through Feed - In this, the workpiece is supported, revolved & feed axially by regulating wheel. Axis of regulating wheel is inclined by 2 to 10 degree with the vertical.

(ii) Infeed : Thr regulating wheel is drawn away to accommodate the workpiece on blade of work rest, then regulating wheel is pushed in to press against the work.

(iii) End feed : In this method grinding wheel & Regulating wheel is dressed to contain the required shape. The workpiece is fed longitudinally from the sides of wheels

Q.1(b)(ii) Explain the closed loop control system with block diagram and state the [6] functions of each element.

Ans.:
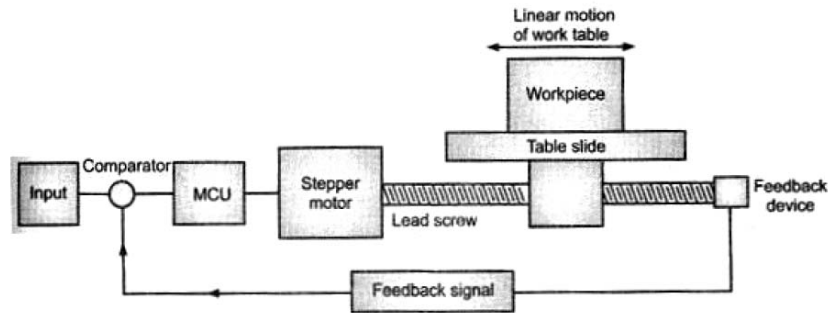
Closed Loops Control System

- The name indicates that the closed loop control system has a loop that is closed as shown in fig. A feedback device is used for this purpose. This makes the design of closed loop a little complicated and expensive. But a very high degree of accuracy is achieved in the movement of slide.
- This system is similar to open loop control system. But it consists of two additional devices in the form of feedback transducer and a comparator as shown in Fig.
- The transducer feedbacks the actual slide displacement to the comparator.
- The comparator compares the actually achieved slide movement with command signal. If there is any error then it is feedback to the MCU.
- The MCU then sends the corrective commands to the drive unit and the cycle repeats until there is no error signal from the comparator.
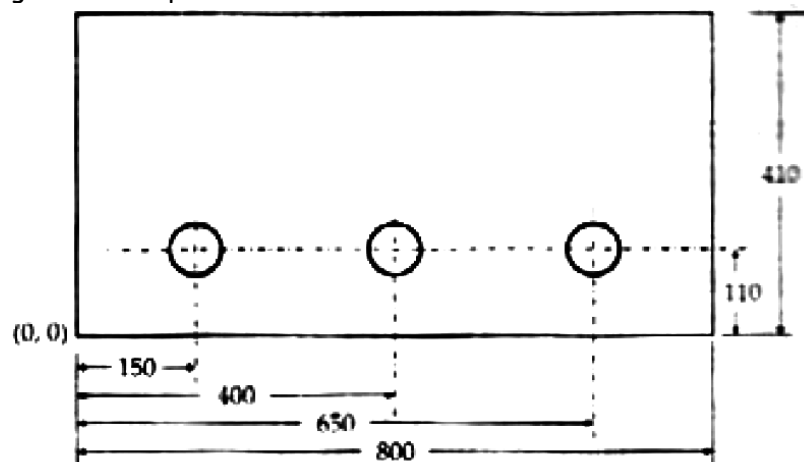
Q.2 Attempt any FOUR of the following : **[16]**

**Q.2(a) State meaning of absolute and incremental coordinate system.** **[4]**

Ans.: **Absolute System:** In this system, the positions are indicated from fixed zero point of reference point.

As shown in figure all tool positions are shown with reference to a fixed zero point.

Incremental System : In this System, the tool positions are indicated with reference to a previously known location. As shown in figure all tool positions are shown with reference to a previous dimension point.
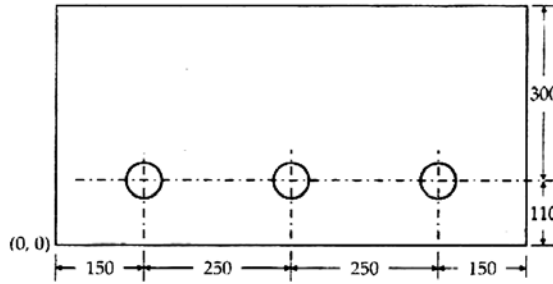
Q.2(b) Explain the use of following codes in CNC part programming. G80, G91, M03, M98   [4]

Ans.:   G80 :   Canned cycle cancel.

G91 :   Incremental Positioning.

M03 :   Spindle start (Clockwise).

M98 :   Call Subroutine.

Q.2(c) List applications of AJM & WJM process.   [4]

Ans.:   Applications of AJM

- Machining of essentially brittle and heat sensitive materials like glass, quartzs, ceramics, etc.
- It is used for drilling holes, cutting slots, polishing, cleaning hard surfaces, such as removal of smudges is also possible.
- Used to removal of metallic smears on ceramics, oxides, resistive coating different materials.

Applications of WJM

- Used to cut thin non metallic sheets.
- Used to rubber, wood, ceramics and many other soft materials.
- Machining of circuit boards.
- Used in food industry.

Q.2(d) Differentiate between planer and planomiller.   [4]

Ans.:

Sr. No.	PLANER	PLANOMILLER
1	Single point cutting tool is used for cutting the job	Multi point cutting tool is used for cutting the job
2	It can cut the workpiece during forward stroke of table only	It can cut the workpiece during both, forward and return stroke of table
3	Different Tools are required as per the shape of job.	Single cutter can be used for nos. of jobs.
4	Process is slow	Process is faster
5	Highly skilled operator is required	Semiskilled operator can be operate this machines.
6	Tool is stationary	Tool is rotating

Q.2(e) Explain the concept of repair cycle analysis and repair complexity.   [4]

Ans.:   Repair Cycle Analysis

- The cycle of inspection, small repair, medium repair and complete overhaul is called as repair cycle. Inspection of machine tool is the first stage of maintenance.

- Small repair carry out repairs of coolant system, replace of belts, tool holder, pumps etc.
- Medium repair involves the activities like wash the parts, paint the surfaces, repair the assemblies, etc.
- Complete overhauling includes disassembly, repair, replace, paint and assembly of each unit.
- The inspection and repair activities are carried out on the machine tool in a particular sequence.
- This sequence is determined forehand in the early life of the machine.
- Thus the cycle of I (inspection) S, M (small or medium repair) and C (complete overhaul) is repeated till three or four overhauling.
- The cycle of inspection, small repair and medium repair between two complete overhauls is called as repair cycle. OR
- The cycle from machine commissioning to first complete overhaul is called as repair cycle.
- e.g. Repair cycle for particular grinding machine I1 – S1 – I2 – S2 – I3 – M1 – I4 – S3 – I5 – S4 – I6 – M2 – 17 – S5 – I8 – S6 – I9 – C

Repair Complexity
- Repair complexity is indicated by a numbers (figures) E.g. R.C. for a centre lathe of small size is 5 R.C. for a medium duty milling machine is between 11 to 15.
- It tells about how complex a machine is to repair.
- Repair complexity cannot be measured.
- It can be decided from relative figures of similar machines.
- It changes with change in specifications of machine.
- It increases with increase in capacity of machine.

Q.3 Attempt any TWO of the following : [16]

Q.3(a) Explain the working principle of PAM with a neat sketch. Disadvantages and applications of PAM. [8]

Ans.: *Plasma Arc Machining*

The material is removed by directing a high velocity jet of high temperature (11000 to 30000 Degree C) ionized gas on the work piece.
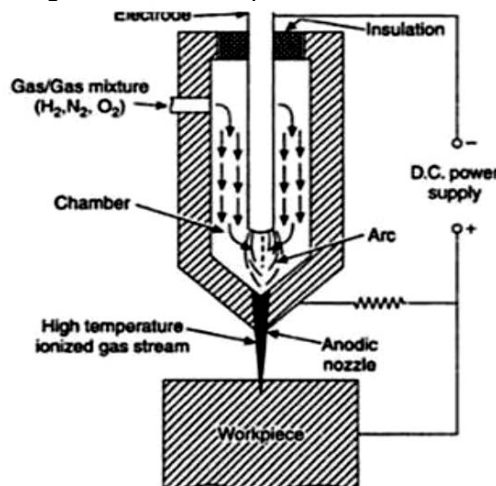

Figure:- Plasma Arc Machining

Working

A gas (H_2, N_2, O_2) is passed through a small chamber in which a high frequency spark is maintained between tungsten electrode (Cathode) and Copper nozzle (Anode). The high velocity electrons generated by arc collide with gas molecules results into ionization of the atoms and cusing large amounts of thermal energy to be liberated. The plasma forming gas is forced to the nozzle with high exit velocity and high temperature. The plasma jet melts

the work piece material and the high velocity gas stream effectively blows the molten metal away.

Disadvantages
1. High initial cost
2. Maintaining the equipment is very difficult
3. Skilled personnel is required
4. Difficult to handle due to higher temperature

Applications
1. For machining hard to cut metals such as super alloys, stainless steel, particularly during cut–off or rough slitting operations
2. For rough turning of very difficult material
3. For stock cutting, plate beveling, profiling and piercing
4. For removing gates and riser from casting in foundry
5. It cuts hot extrusion to desired lenghts.
6. It finds use in the manufacturing of automotive and rail road components

Q.3(b) **Prepare a part program for machining component as shown in Figure. Use following data: cutting speed: 1200 rpm, feed: 60mm/min, thickness of component 3 mm, Tool reference position is 4 mm above the surface of the workpiece. Assume suitable data if any. Neglect cutter radius compensation.** [8]
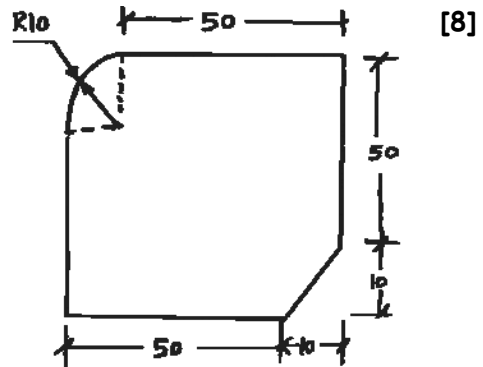

Ans.: Part Programming:
N01 G90 G71 G94
N02 G00 X00 Z4
N03 G00 Z-7 X00 Y00 F60 S1200
N04 G01 X50
N05 G01 X00 Y-10
N06 G01 X00 Y50
N07 G01 X-50 Y00
N08 G03 X-65 Y-10 I00 J10
N09 G01 X00 Y00
N10 G00 Z4
N11 M02

Q.3(c) **Write CNC programme for milling a component as shown in figure with end mill of 20 mm diameter, thickness of plate 10 mm, feed 90 mm/min, spindle rpm 450. Assume suitable data if necessary.** [8]

Ans.:
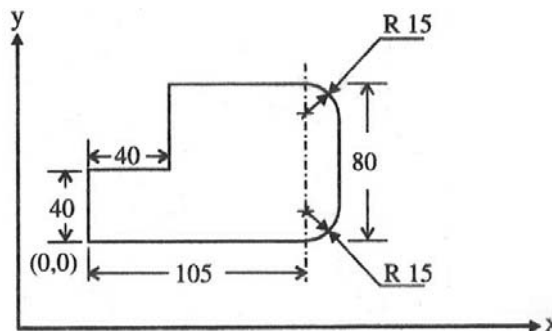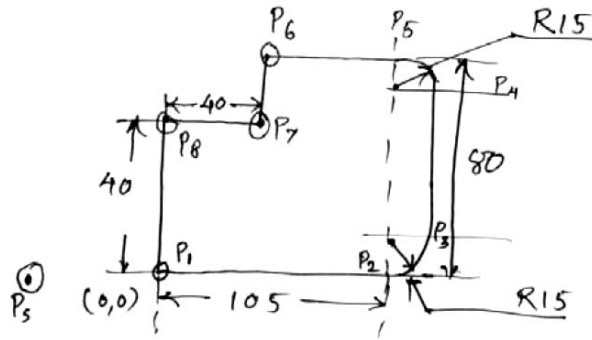
Pt	X	Y	R
Ps	-10	0	
P1	0	0	
P2	105	0	
P3	120	15	15
P4	120	65	
P5	105	80	15
P6	40	80	
P7	40	40	
P8	0	40	
P1	0	0	

```
N10 G90 G21
N20 T01 M06
N30 S1000 M03
N40 G00 X-10 Y0
N50 G00 Z5 M08
N60 G01 Z-10
N70 G01 G42 D01 X0 Y0
N80 G01 X105 Y0
N90 G03 X120 Y15 R15          OR G03 X120 Y15 I0 J15 ( If I & J method is used for arc)
N100 G01 X120 Y65
N120 G03 X105 Y80 R15         OR G03 X105 Y80 I-15 J0
N130 G01 X40 Y80
N140 G01 X40 Y40
N150 G01 X0 Y40
N160 G01 X0 Y0
N170 G00 G40 Z5
N180 G91 G28 Z0
N190 M05 M09
N200 M30
```

Q.4(a) Attempt the THREE of the following: [12]

Q.4(a)(i) Differentiate between breakdown maintenance and preventive maintenance. [4]

Ans.:

Sr. No.	Breakdown Maintenance	Preventive Maintenance
1	Breakdown maintenance is basically the "run it till it breaks" maintenance mode. No actions or efforts are taken to maintain the equipment	Actions performed on a time or machine run-based schedule that detect, preclude, or mitigate degradation of a component

2	Increased cost due to unplanned downtime of equipment.	Reduced equipment or process failure
3	Increased labor cost, especially if overtime is needed	Less labor cost because of planned maintenance.
4	Cost is involved with repair or replacement of equipment	Estimated 12% of 18% cost savings over breakdown maintenance program
5	Possible secondary equipment or process damage from equipment failure	Increased component life cycle.
6	Inefficient use of staff resources	Efficient use of staff resources

Q.4(a)(ii) Explain the following terms in CNC machine programming: [4]
        (1) Dry run
        (2) Jog mode
   **(3) Block by Block execution**
Ans.: **Terms In CNC Machines:**

    (1) Dry Run: It is the trial run without actual running of CNC machine for checking correct shape of the component. It shows correctness of the steps given in the program. It give idea about the tool impact collision with the chuck and other machine parts due to incorrect program.

    (2) Jog Mode: This mode of machine is useful for initial setting of machine tool before doing manufacturing of component. Jog mode means warm up of machines slides to check for initial settings. In this mode machine axes are moved by using direction keys provided on the control panel of the CNC machine. With this jog mode operator can set the tool /work piece at required position with reference to the location of machine table or chuck.

    (3) Block By Block execution: The CNC program consists of program blocks which are numbered as N10, N20 etc. In CNC single block mode only one block of CNC will be executed, in CNC execution of program can be done completely or Block By Block.

Q.4(a)(iii) Sketch a planomiller with labels. [4]
**Ans.:** **Planomiller :**
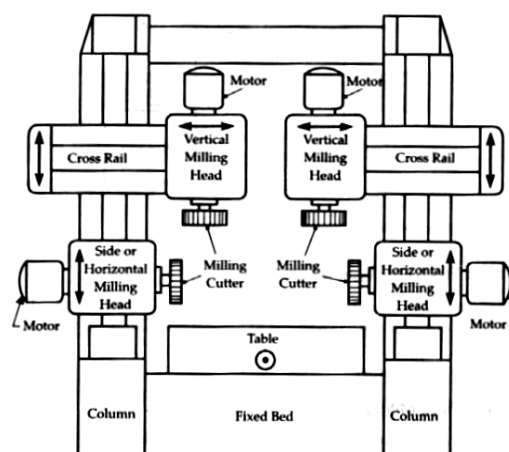
Q.4(a)(iv) Explain the dressing and trueing of grinding wheel with neat sketches. [4]
**Ans.:** **Grinding Wheel Dressing & Truing:**
    Dressing removes loading and breaks away the glazed surface so that sharp abrasive particles are again presented to work. A common type of star dresser is used to dress the wheel. The dresser is held against the wheel and moved across the face of revolving wheel. Dressing is done to regain grinding wheels cutting capability. The dressing improves the

surface finishing obtained while grinding. It is carried out where high degree of surface finishing is desired.
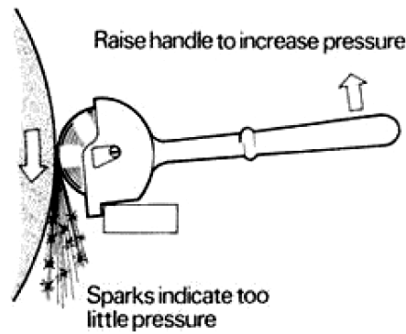
Truing of Grinding wheel:

Truing is the process of changing the shape of grinding wheel as it becomes from an original shape owing to the break away of the abrasive and bond. This is done to make wheel true and concentric to the bore. Truing and dressing are done from the same tool but not for the purpose. The truing can be done with the help of diamond tool but the feed rate must not exceed 0.02 mm otherwise grooves may be cut on the wheel.
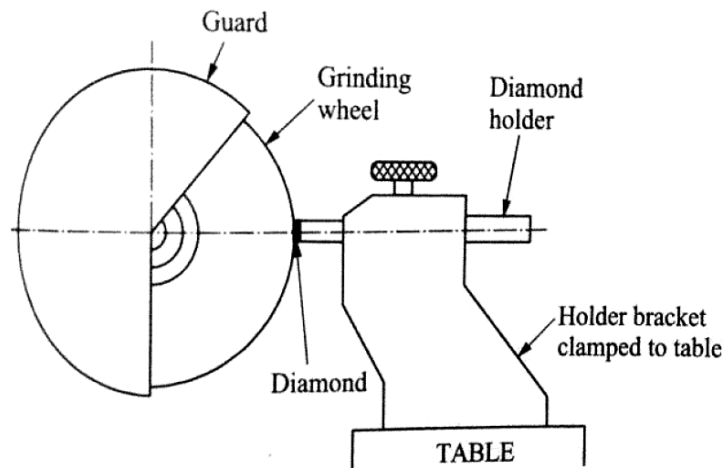
Q.4(b) Attempt any ONE of the following: [6]

Q.4(b)(i) Differentiate between end milling and facing operation. [6]

Ans.:

Sr. NO.	End Milling	Facing operation
1	In this process End Milling cutters are used to produce sloting, recessing and small facing operations.	In this milling operation number of flat surfaces are machined which are right angles to the axis of rotating cutter.
2	Cutter used here is End mill cutters. Like shell end mill cutter and solid end mill cutter. Single cutter is used at a time.	Cutter used here is side and face mil cutter. Number of cutters of diffent diameter can be used at a time.
3	This process is used when machining area is large	Used for small machining area
4	Single face is machined at a time.	Number of parallel or perpendicular face can be machined simultaneously.
5	Used for simple geometry jobs	Used for complicated geometry jobs

Q.4(b)(ii) Compare capstan and turret lathe. [6]

Ans.:

Sr. No	Capstan lathe	Turret lathe
1	It is a light duty machine	It is a heavy duty machine
2	The turret head is mounted on the ram and the ram is mounted on the saddle.	The turret head is directly mounted on the saddle and the saddle slides over the bed ways
3	The saddle will not be moved during machining	The saddle is moved along with the turret head during machining
4	The lengthwise movement of turret is less	The lengthwise movement of turret is more
5	Short work pieces only can be machined.	Long work pieces can be machined
6	It is easy to move the turret head as it slides over the ram	It is difficult to move the turret head along with saddle
7	The turret head cannot be moved crosswise	The turret head can be moved crosswise in some turret lathes
8	As the construction of lathe is not rigid, heavy cut cannot be given	As the construction of lathe is rigid, heavy cut can be given
9	It is used for machining work pieces up to 60mm diameter	It is used for machining work pieces up to 200mm diameter
10	Collate is used to hold the work piece	Jaw chuck is used to hold the work piece

Q.5 Attempt any FOUR of the following: [16]

Q.5(a) Compare the pull broach and push broach. [4]

Ans.:

Sr. No.	Pull Broach	Push Broach
1	It is designed to be pulled through the holes	It is designed to be pushed through the work piece by special press
2	The pull broach undergoes tensile force	The push broach undergoes compressive force
3	Length of broach is more	Length of broach is short
4	Long and slender broaches are possible to use	Short and stocky broaches are used
5	Pull broaches are used for sizing as well as removal of large stock	Push broaches are used for sizing only
6	It has large number of teeth	It has less number of teech

Q.5(b) State how maintenance of gears and machine belts are done. [4]

Ans.: **Maintenance Practices for Gears:**
- Select the proper gear.
- Select proper raw material for manufacturing of gear.
- Do the balancing of gear properly.
- Do the proper alignment of gear on shaft and key.
- Check the alignment of gear with its meshing gear.
- Check the lubrication and change the oil on specified intervals.
- Minor repairs like burr or imperfections can be cleared by using a fine oil stone or file.
- If major repair is required remove the gear from assembly, repair it and assemble.

Maintenance Practices for machine belts:

- The belt is free from damages.
- It must be properly aligned.
- It should be properly assembled to the other mating parts
- Check tension in the belt

Q.5(c) **What is a dividing head in gear cutting process? With a neat sketch explain the construction of any one dividing head.** **[4]**

Ans.: Indexing is the operation of dividing the periphery of a piece of work into any number of equal parts. In cutting spur gear, equal spacing of teeth on the gear blank is performed by indexing. Indexing is accomplished by using a special attachment known as dividing head or index head.

Dividing heads are of three types:

(i) **Plain or Simple dividing head :** It comprises of cylindrical spindle housed in a frame and a base bolted to machine table. The index crank is connected to tail of the spindle directly, crank & spindle rotates as one unit. Work is mounted as nose end of the spindle by chuck. Tail stock is separately bolted to the machine table.
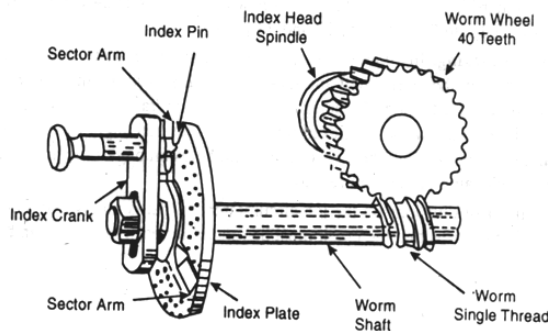
(ii) **Universal dividing head :** As the name implies, this type dividing head can be used to execute all forms of indexing. The important parts are worm and worm gear, index plate, sector arm, change gear & spindle. The worm gear has 40 teeth's & worm is single threaded, thus 40 turn of the crank will rotate the spindle through one complete revolution
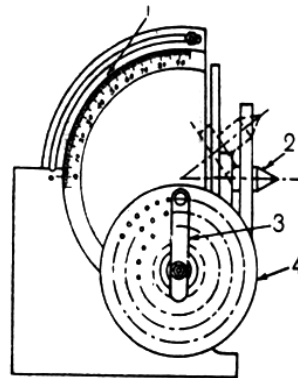
(iii) **Optical dividing head :** It is used for precise angular indexing during machining. The mechanism comprises a worm gear which is keyed to the spindle and may be rotated by a worm. A circuit glass scale graduated in 1° division is rigidly mounted on the worm wheel. Any movement of the spindle effected by rotating the worm is read off by means of a microscope fitted on the dividing head body, the eye piece has a scale having 60 divisions & each division is equivalent to 1' movement of circular scale.

Q.5(d) Differentiate between honing and lapping. [4]

Ans.:

Sr. No.	Honing	Lapping
1	Honing is applied to get high degree of surface finish as well as to correct the roundness, taper in the work.	Lapping is applied to get geometrical true surfaces, correct minor surface imperfections and improve the dimensional accuracy.
2	Honing is slow speed finishing process.	Lapping is low pressure, low speed abrading process to refine surface finish.
3	Honing action is rotates and reciprocate in the hole of work piece.	Lapping action is either rotary or reciprocating
4	Honing is applied to get high degree of surface finish as well as to correct the roundness, taper in the work.	Lapping is applied to get geometrical true surface, correct minor surface imperfections and improve the dimensional accuracy.
5	Metal removal rate in honing is 0.5 mm in primary and 0.01 mm for secondary.	Metal removal rate in lapping is 0.005 mm to 0.01 mm
6	Honing stones are used as cutter.	Abrasive particles are loaded on laps are used as a tool.
7	Applications are on internal and external cylindrical surfaces.	Mostly used on flat or regular surfaces.

Q.5(e) Give the advantages and disadvantages of gear hobbing process. [4]

Ans.: **Advantages:**
1. Versatility, covers variety of gear types.
2. Indexing is continuous hence no error
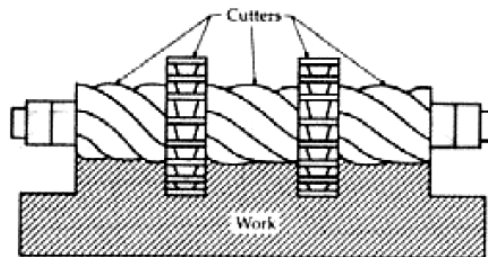3. High rate of production.

Disadvantages:
1. Not adopted to generate internal gears.
2. Restricted adjacent shoulders larger than root diameter of the gear.
3. Splines and serrations are not suitable for hobbing.

Q.5(f) Explain gang milling. [4]

Ans.: **Gang Milling:**

When two or more milling cutters are mounted on an arbor so that each cutter will produce its own distinctive surface as work piece is fed to it, the operation is called " gang milling"
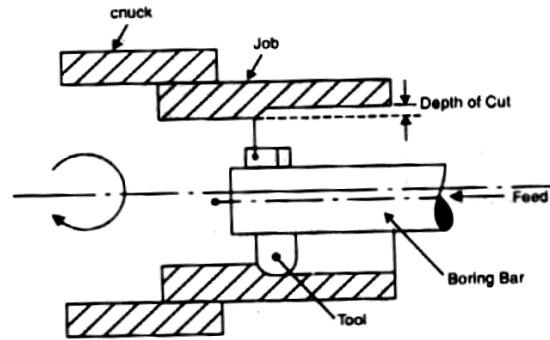
Q.6 Attempt any FOUR of the following: [16]

Q.6(a) Define boring, State types. [4]

Ans.: When internal surface of a hollow part is turned, that is, single point tool is used for enlarging a hole, the operation is called as boring.

**Types of boring:**
Counter boring
Counter sinking
Spot facing

Q.6(b) Explain buffing operation. State its advantages. [4]

Ans.: **(i) Buffing:**
- Buffing is a final operation to improve the poish of a metal and to bring out maximum luster. It is a operation prior to plating.
- Buffing does not mountain flatness or roundness, it is used only to obtain very smooth reflective surfaces.
- It removes negligible amounts of metal. The size of the work is changed very little sometimes 0.0025 to 0.0075 mm
- In buffing the rubbing action is more gentle than aggressive cutting action used in polishing.
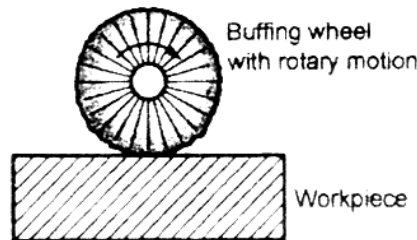
Principle of operation

Principle of operation:
- Buffing may be done by holding the workpiece in hand and bringing it into contact with a revolving buffing wheel.
- The operator pressure the part against the charged buffing wheel at considerable pressure.

Advantages:
1. No surface preparation is required.
2. Suitable for ferrous/ non ferrous alloys.

Q.6(c) Give classification of broaching machines. [4]

Ans.: **Classification of Broaching Machine**
According to the Construction
1. Horizontal Broaching Machine
2. Vertical Broaching Machine
3. Continuous Broaching Machine

According to the application of Broaching Machine
1. Internal Broaching Machine
2. External Broaching Machine

Q.6(d) What is repair complexity? How is it useful to the maintenance team? [4]

Ans.: It is important for maintenance planning to consider complexity of repair of machine tool. In a simple manner. If machine tool has more number of mechanisms and devices then it is called as complex one and its maintenance is also complicated.
- The complexity of the machine tool play a very important role in the maintenance and it decided the nature of small/ major repair and repair cycle, maintenance staff, spares requirement, repair cost is also dependent on the complexity of the machine tool.

- An index is generally used to designate a coparatively complexity of different machines.
- This index has been finalized taking into account the power transmission devices, hydraulic units guides surfaces, intricate mechanisms, etc

Types of machine/ equipment	Repair complexity number
Boiler	12
Air compressor	8
Turbine	14
Rolling mill	15
Centre lathe	5

Higher the repair complexity index, high number of activities i.e. longer repair cycle for the machine.

Use of Repair Complexity:
1. To calculate maintenance staff size.
2. To design the inventory required for spares.
3. To forecast the maintenance cost.
4. To design repair cycle of the machine tool.
5. Number of critical maintenance points can be find out.

Q.6(e) **Explain slot milling.** **[4]**

Ans.: **Slot milling :** Rectangular, T and dovetail slots are milled on vertical spindlie machines by means of suitable shank type milling cutters. Rectangular slots can also be machined on horizontal machine.

Key ways can be machined with special cutters

Splines may be milled on horizontal spindle machines by using single / double angle cutters.
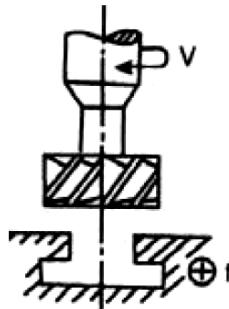
Q.6(f) **Define part program. Explain the term preparatory functions and miscellaneous** **[4]** **functions in the context of CNC programming.**

Ans.: **Context of CNC programming**

Part Program : Part programming– Part program defined as the way in which the blocks of instructions are planned and written such that after its execution on the CNC machine the required shape is obtained on the work piece in minimum possible time.

OR

Part program is a set of instructions the machine tool about the processing steps to be performed the manufacture of component.

Preparatory functions are G codes. G codes are designated by the letter G and a two digit numeric value. These codes are the most important functions in CNC programming because they direct the CNC system to process the coordinate data in a particular manner. Some examples are rapid travers, circular interpolation, linear interpolation, and drilling.

Miscellaneous function : The M word is used to specify certain miscellaneous function such as spindle starts, spindle stop, coolant ON/OFF etc. The miscellaneous function as are those functions which do not related to the dimensional movement of the machine. These function actually operate some control on the machine. For example M02 which indicate end of program.

❑ ❑ ❑ ❑ ❑