



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.

Q. NO. 1A)

- i) (04 marks, one for each, any four)

Ideal characteristics of electrode materials used in EDM.:

- 1) It should be a good conductor of electricity
- 2) It should be a good conductor of heat
- 3) It should be easily machinable to any shape at economical cost
- 4) It should have efficient rate of material removal from the workpiece during machining
- 5) It should resist deformation during the machining by erosion process
- 6) It should have low or minimum wear rate
- 7) It should be available in variety of shape

- ii) (04 marks, one for each, any four)

Differences between subroutine and canned cycles :

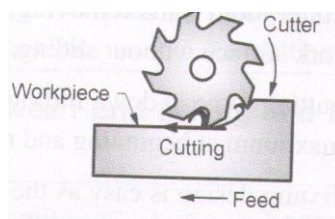
Canned cycles	Subroutine programme
Canned cycle or fixed cycle may be defined as a set of instructions, inbuilt or stored in the system memory, to perform a fixed sequence of operations.	Subroutines provide the capability of programming certain fixed sequence or frequently repeated patterns.
Canned cycles are used for repetitive and commonly used machining operations.	Subroutine may be called any time or repeated any number of times.
It consists of some very common moves of	These are repeating some moves on a



different machines coded	component for variable number of times
They don't allow optimization of program in their movements fixed for operation	They allow making their own cycles with different parametric dimensions at different locations. i.e. user defined canned cycles

iii) (02 marks for explanation and 02 for sketch)

Down Milling: In this process milling cutter is rotated in the same direction in which the work piece travels.. The thickness of chip is maximum when the tooth begins its cut and it reaches to the minimum when the cut terminates. the cutter tooth starts removing metal immediately on reaching the work surface without sliding . The cutter force in this milling is variable throughout the cut. The chips are disposed off easily and do not interfere during cutting. It is not recommended on light or old machines but it is carried out on rigid machines provided with backlash eliminator.



Down Milling Cutting process

iv) (04 marks for explanation)

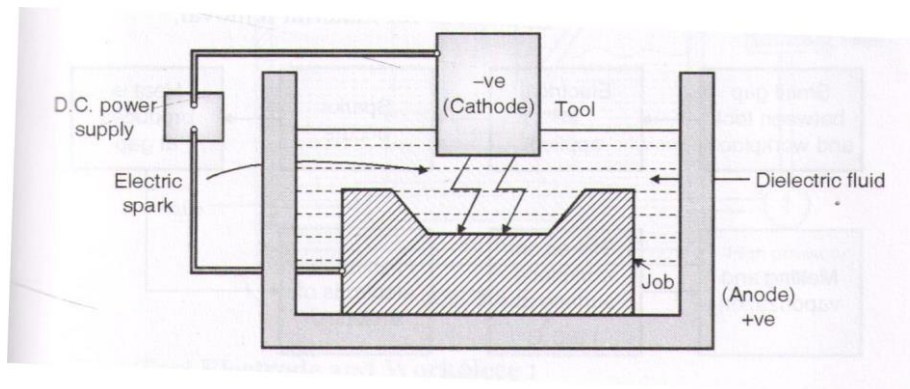
Grinding wheel dressing : Dressing is the operation of removal of the dull and workout grains, metal particles from the cutting surface of a grinding wheel to restore its cutting ability for grinding. The frequency of dressing will depends upon type of wheel, application, and material to be grounded.

After use, the wheel becomes dull or glazed. Glazing of the wheel is a condition in which the face or cutting edge takes a glass like appearance. It indicates that the cutting points of the abrasives have become dull and worn down the bond. It decreases the cutting capacity. Wheel becomes smooth and it instead of cutting action provides a sort of rubbing action only.

Dressing of grinding is done to improve the surface finish and accuracy of the work piece. It also increases the material removal rate. Single point and multipoint dressers are used for dressing of the grinding wheels.

Q. NO. 1B) i) (02 marks for principle, 02 for working and 02 for sketch)

Principle of Electro discharge machining: It works on the principle of metal removal by using combination of electrical and thermal energy. The energy is utilized to create electrical spark ;and heat is produced for erosion of metal. The principle of spark erosion is utilized in Electro discharge machining.



Working : The Figure shows the workpiece and the tool are electrically to DC electric power supply. The workpiece is connected to positive acts as an anode and electrode to negative as a cathode.

Both tool electrode and workpiece are separated by a spark gap of about 0.001 to 0.50 mm. Electrical input given will create a spark due to small gap producing a strong electrostatic field to emit electrons causing ionization gap. The electrical energy discharged in the gap and caused breakdown of dielectric within few microseconds. Shock waves in the dielectric are created and impact of electrons on the work material causes transient pressure of 1000 kg/cm². It creates a high temperature of work material and the metal melts instantaneously.

Q. NO. 1B) (02 marks each , any three)

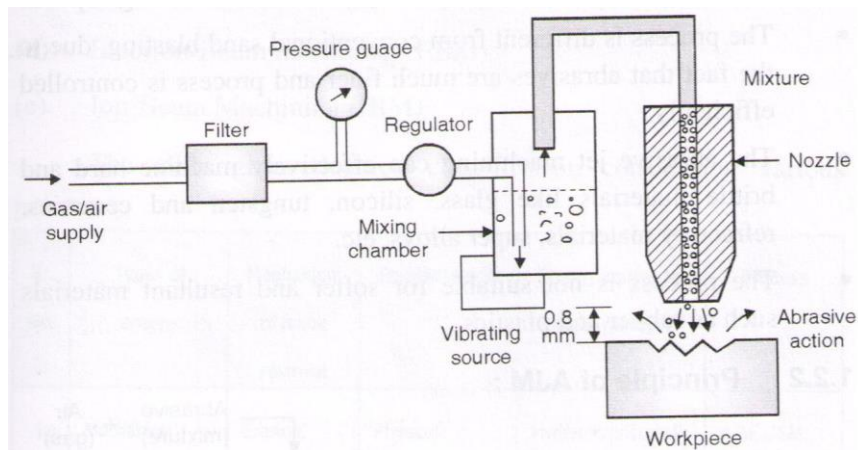
ii) Process parameters of Laser Beam Machining :The performance of the LBM process can be studied with the help of controlling following parameters,

- Intensity of laser beam: By focusing a laser beam in a spot of 0.01 m², it can give power density of 100000kW/ cm². The focused beam radius is directly proportional to the laser wavelength and the focal length.
- Pulse duration of laser beam: The pulse durations about 6 to 12 pulse/ min. It depends upon the application to be performed like welding, drilling, cutting etc.
- Focal length: It is the distance between laser beam and the workpiece. If the laser is very close to the workpiece the divergence of the beam occurs for small focal length in the metal cutting. : It is important in drilling operation.
- Mode of laser operation : It can operate in continuous mode and pulsed wave mode



Q. NO. 2 a) (02 marks for sketch and 02 for Advantages ,Any four)

Abrasive Jet Machining (AJM) :



Applications of AJM:

1. Deburring , etching and cleaning of hard and brittle materials, alloys and non metals.
2. Machining brittle and heat sensitive materials like glass, quartz, and ceramics etc
3. It is used for drilling holes, cutting slots, cleaning hard surfaces polishing etc
4. Abrasive jet cutting is used for removal of metallic smears on ceramics, oxides on metals, resistive coating
5. Frosting and abrading of glass articles.
6. Trimming of resistors used in hybrid power amplifier circuit

Q. NO. 2 b) (02m marks for advantages and 02 for disadvantages any four)

Advantages of Plasma arc machining :

1. High speed of cutting e.g. 6 mm mild steel plate can be cut at a speed of 3 m/min.
2. Equally effective on any metal regardless its hardness
3. Smooth cuts free from contaminants are obtained in the process.
4. There is no contact between tool and workpiece
5. It is three to eight times faster than oxy fuel cutting
6. Profile cutting of stainless steel can be very easily done by this process

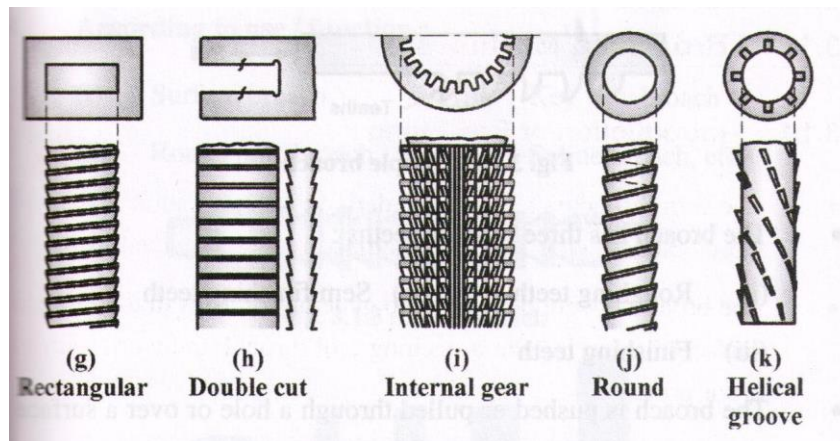


Disadvantages :

1. Due to high heat, metallurgical change on the workpiece surface
2. Safety precautions are necessary for the operator and those in nearby working area
3. It increases cost of process
4. On the thicker material it will lead noise, fume and arc glare hence water cooling is needed.

Q. NO. 2 c)(01 mark for each shape any four)

Shapes that can be machined by broaching process are shown in the figure



Q. NO. 2 d) (02m marks for advantages and 02 for disadvantages any four)

Advantages of CNC Machines :

1. Reduced lead time
2. Elimination of operator error
3. Lower labour cost
4. High accuracy
5. Elimination of jigs and fixture
6. Flexibility
7. Reduced inspection
8. Less scrap



Disadvantages :

1. Higher investment cost
2. Higher maintenance cost
3. Costlier CNC personnel
4. Planned support facility

Q. NO. 2 e) (04 marks)

Classification of grinding machines :

- a) According to quality of surface finish
 - i) Rough and non precision grinding machines
 - 1) Floor stand and bench grinders
 - 2) Portable and flexible shaft grinders
 - 3) Swing frame grinders
 - 4) Abrasive belt grinders
 - ii) Precision grinding machines
 - 1) External or internal cylindrical grinding
 - 2) Surface grinders
 - 3) Form grinders
- b) According to type of surface generated
 - i) Cylindrical grinder
 - 1) Center type plain
 - 2) Centre type universal
 - 3) Centre less
 - ii) Centre less grinder
 - 1) Through feed grinders
 - 2) In feed grinders



- 3) End feed grinders
- iii) Internal grinders
 - 1) Chucking grinder
 - 2) Planetary grinder
 - 3) Centreless grinder
- iv) Surface grinder
 - 1) Horizontal grinders
 - a. Reciprocating table
 - b. Rotary tables
 - 2) Vertical spindle
 - a. Reciprocating table
 - b. Rotary table
- c) According to specialized application
 - i) Tool and cutter grinder
 - ii) Form grinder
 - iii) Hand grinder
 - iv) Crankshaft grinder
 - v) Thread grinder
 - vi) Cam grinder

Q.3. Answer any two of the following.

(2*8=16)

a) Write a part program to machine the part given in figure 1. On a CNC milling machine.

Point	X	Y
Ps	-5	-5
P1	-5	-45



P2	-5	65
P3	87.5	65
P4	87.5	-5
P5	62.5	-5
P6	65.5	30
P7	47.5	45
P8	-5	-5

Cutter path Ps—p1—p2—p3—p4—p5 – p6 –p7 –p8
Co-ordinate as per G90

Part program :-

01234

N10 G28 U00 V00 W00 EOB

N20 G90 G21 G94 G40 EOB

N30 M03 S900 M08 EOB

N40 G00 Z5 EOB

N50 G00 X5 Y-5 EOB-----Ps

N60 G00 Z-3 F80 EOB

N70 G00 X-5 Y45 EOB-----P1

N80 G01 X-5 Y65 EOB-----P2

N90 G01 X87.5 Y65 EOB-----P3

N100 G01 X87.5 Y-5 EOB-----P4

N110 G01 X62.5 Y-5 EOB-----P5

N120 G02 X62.5 Y30 R15 EOB ----P6

N130 G01 X47.5 Y45 EOB ---P7

N140 G01 X-5 Y45 EOB -----P8

N150 G00 X-5 Y-5 EOB

N160 G00 Z5 M05 EOB

N170 G28 U00 V00 W00 EOB

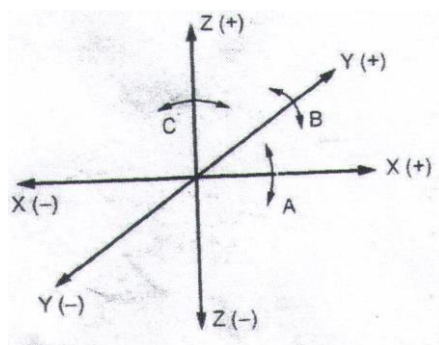
N180 M09 EOB

N190 M30 EOB.

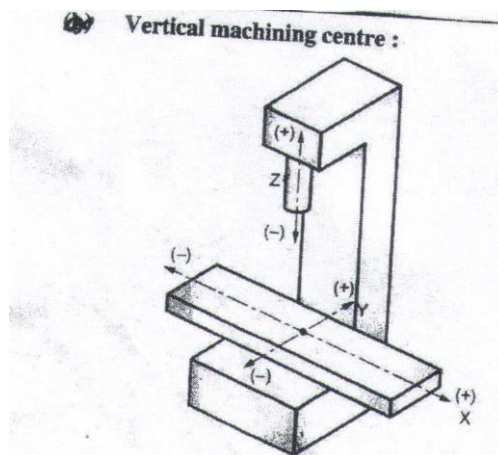
Q. 3 b) How are the axes identification in CNC machines ? Justify your answer with neat sketches for VMC ,HMC ,and CNC lathes.

(02 marks for explanation of axis identification and 02 each for axis explanation)

- To obtain desired shape of the work piece it is necessary to move the spindle , slides in a different direction.
- In part programming the requirement is to determine co-ordinates for given product as per drawing and it is essential to identify the machine axes to determine the co-ordinate as per the standardized system.
- As per three dimensional Cartesian co-ordinate system the axis identification consist of---
 - 1) Linear Axis--- X,Y,Z axes (Straight Movement)
 - 2) Rotary Axis---- A,B,C axes (Rotary Movement)



i) VMC

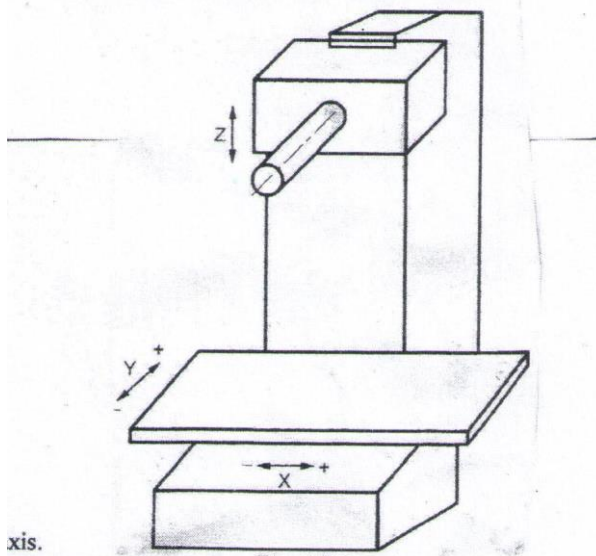


- Z axis---1) Main spindle axis.
2) In VMC Z(+ve) means cutter movement upward.
3) In VMC Z(-ve) means cutter movement downward.
- X axis---1) Horizontal –work holding device.
2) X (+ve) means as being to the right when looking from the spindle towards column.
3) X (-ve) means as being to the left when looking from the spindle towards column.
- Y axis—It is perpendicular to X and Z axes. It indicates cross travel of the work table

ii) HMC

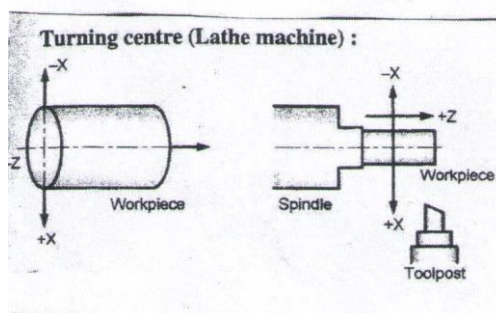


Horizontal machining centre :



- Z axis---1) spindle axis.
2) In HMC Z(+ve) increases distance between work piece and tool.
3) In HMC Z(-ve) used to specify depth of cutting.
- X axis---1) Always Horizontal and parallel work holding device. Indicates longitudinal movement of worktable.
2) X (+ve) means motion is to the right when looking from the spindle towards the work piece.
- Y axis—It is perpendicular to X and Z axes. Y (+ve) with (+ve) X and (+ve) Z.

CNC lathe



In lathe only two axes are---

Z axis--- The axis of rotation of the workpiece is spevified by Z axis

X axis--- The radiac location of the cutting tool is represented by X axis

(if the figure of right hand rule to indentify the axes of CNC Machine is drawn then also full marks to be given.)

Q 3) C) (04 marks one for each differentiation any four)

a) Differentiate between EDM and LBM processes.

Sr No.	Point	EDM	LBM



1	Principle	It works on the principle of spark erosion by interrupted electric sparks between tool and work piece.	It works on the principle of heat energy produced by laser beam for metal removal.
2	Setup	Tool, electrolyte. w/p and electrical power supply.	Ruby rod, lash. Cooling unit, w/p. lens, electrical power supply.
3	Tool electrode	It required in physical from made of graphite, copper.	No need of electrode, laser beam is a cutting source.
4	Material removal rate	It is high about 5000 mm ³ /min.	It is very low about 5mm ³ /min
5	Accuracy / surface finish	Less accuracy and surface finish.	More accuracy and better surface finish.

Q 3 c) b) Classification of non-traditional process on the basis of type of energy used-

(04 marks one for each classification)

Sr No.	Types of Energy	Mechanism of metal removal	Transfer media	Energy source for metal removal	Process.
1	Mechanical	Erosion , shear	Physical contact, high velocity particles.	Hydraulic/ pneumatic	AJM,USM, WJM
2	Chemical	Chemical dissolution, etching	Reactive environment.	Corrosive agent	CHM,
3	Electro-chemical	Ion displacement.	Electrolyte.	High current.	ECM
4	Thermal / Electrothermal	Fusion, vaporisation	Hot gases, electrons, radiation.	High voltage, high amplification, ionized material.	EDM, LBM,PAM,EBM, IBM.

Q4

A)

i) Differentiate between pull broach and push broach

any 4 points ,01 mark each

Pull Broach	Push Broach
1. Pulled through work piece	Pushed through work piece
2. Subjected to tensile load	Subjected to compressive load
3. Long in length	Short in length



4. More stock can be removed	Less stock is removed
5. More no. of teeth's	Less no. of teeth's

Q 4 A ii) Explain salient features of capstan and turret lathe

any 4 points ,01 mark each

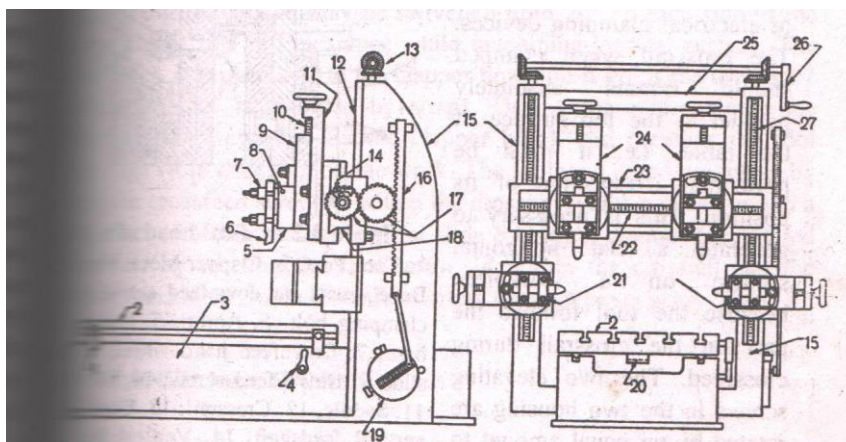
1. Suitable for batch or mass production
2. More productive for quick engagement and over lapped functioning of the tools
3. feeding of the job and rapid speed change
4. Enable repetitive production of same job requiring less involvement, effort and attention of worker
5. An axially movable indexable turret in place of tail stock
6. Series of operations can be performed
7. Manufacturing of large identical pieces in a minimum time

Q 4 A iii) Sketch a planer and explain its working marks

Sketch 02 marks , Working 02

Planing is a machining process in which metal is removed by the relative linear movement of the tool over the surface of the work.

The planning machine consists of a reciprocating table on work is held. A single point cutting tool is held in a tool post carried on a vertical slide, the saddle of which can be traversed on a cross rail. The cutting takes place during forward stroke of the table and the tool is lifted by a mechanism to avoid rubbing during the return stroke. The tool slide and saddle on the cross slide provide feed in vertical and horizontal directions respectively. To machine angular surfaces, the tool slide can be swiveled to the desired angle.



(Block diagram should be given full marks.)



Q 4 A iv) List gear finishing methods and explain any one of them in detail list 1M, explanation 3M

Gear finishing methods are;

1. Gear shaving
2. Gear grinding
3. Gear lapping
4. Gear honing
5. Gear burnishing

Gear shaving: It is a corrective process. It will not make a bad gear good, but will make good gear better. This method is widely adopted for finishing spur and helical gears, before hardening. The metal is removed from the teeth with a cutter resembling a gear or a rack. Each tooth of the cutting tool is serrated to provide a series of cutting edges.

Gear grinding: It is a finishing process to remove considerable amount of the metal after heat treatment to obtain predetermined quality gear. There are three general methods of gear grinding 1. Form wheel grinding 2. Generation grinding 3. Threaded wheel grinding

Gear lapping: It is the process of refining the gear element after the heat treatment. The process is done by rotating the gear and the lap tool as inter meshing gears, with abrasive compound forced between the teeth.

Gear honing: The process is carried out on high speed machines. The work is meshed with the honing tool in a cross axes relationship. The honing tool drives the work gear while it traverses back and forth in a parallel path to the work gear axis. The gear is run in both the directions during the process.

Gear burnishing: The operation consists essentially of rolling the work gear with one or several burnishing gears whose teeth are very hard, smooth and accurate. The latter gears are driven by a motor.

Q 4 B)

i) What is boring operation? Give specifications of vertical boring machine (Boring 2M, Specifications 4M)

Boring is a machining process in which internal surfaces of revolution are generated with single point tool. It is enlarging of drilled, cored holes. Boring machine are specified on following parameters;

1. Boring capacity
2. Max boring depth
3. Max spindle travel
4. Table surface
5. Table traverse
6. Spindle rotation
7. Spindle feed
8. Spindle motor

(values of above parameter of machine may change according to manufacturer)

Q 4 B ii) Name the methods by which gears are produced by machining. Explain any one method (List of methods 1M, explanation 5M)

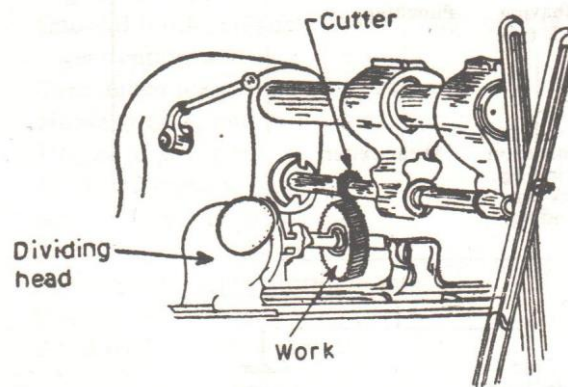


Gear production by machining the various methods are;

1. Gear milling
2. Gear Hobbing
3. Gear shaping
4. Shear cutting of gears
5. Gear broaching
6. Bevel gear cutting

Gear milling;

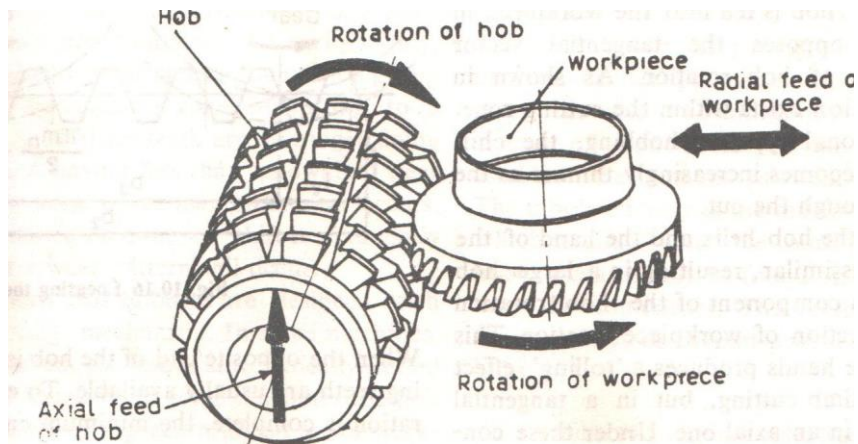
Here a formed cutter is passed through the gear blank to effect tooth gap. Spur, helical, worm wheels and bevel gears can be manufactured by milling. Gear milling is less costlier and less accurate process. As the tooth depends upon the module, pressure angle and number of teeth, a series of cutters are selected for gear cutting. Each cutter cuts only limited range



Gear hobbing:

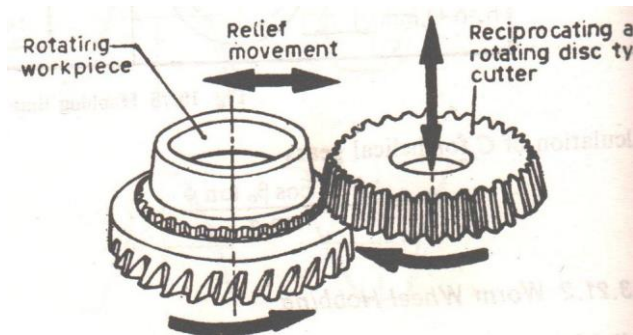
Gear hobbing is a continuous generating process in which the tooth flanks of constantly moving work piece are formed by equally spaced cutting edges of the hob. Every hob tooth, which contacts the gear along the line of action, produces one enveloping cut. Thus all enveloping cuts form a polygon of tangents to the involutes which on its corners forms a crest and deviates from the involutes curve.

The direction of feed of the hob can be achieved in three ways



Gear shaping:

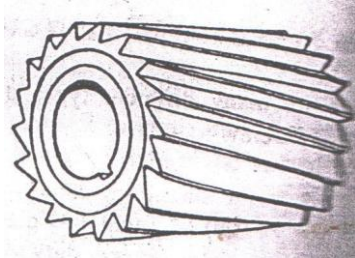
In gear shaping the pinion type cutter is gear with cutting edges and means are provided to rotate the cutter in mesh with the gear to be produced.



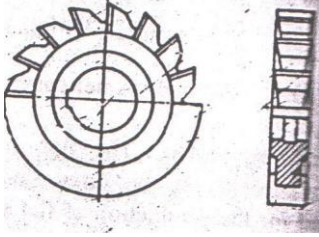
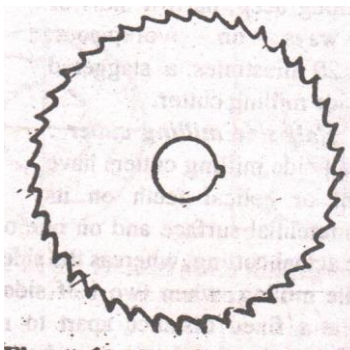
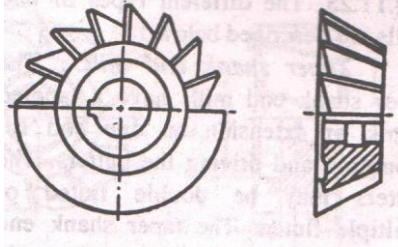
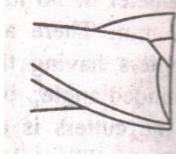
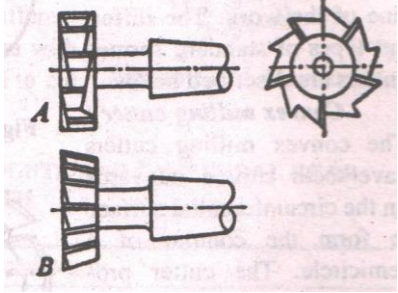
(Block diagram or line diagram should also be given full marks.)

Q5

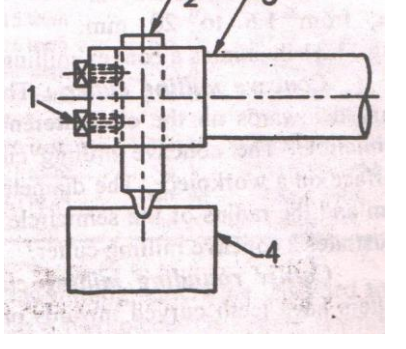
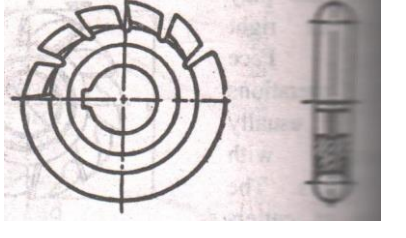
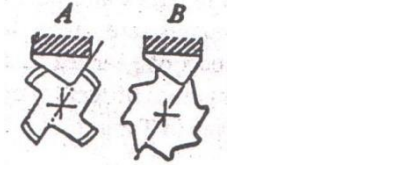
i) Draw and state use of any two standard milling cutters (sketch 01 mark; use 01 mark of each any of the above types. Students might have drawn sub types of cutters then also weight age to be given, any 02)

Type of cutter	Sketch	Use
Plain Milling Cutter		Production of flat surfaces parallel to the axis of rotation of spindle



Side milling cutter		Intended to removing metals from side of the work
Metal slitting saw		Parting off or slotting operations
Angle milling cutter		These cutters are used for machine angles
End mill		End mills are used for light milling operations
T slot milling cutters		Special form of end mills for producing T slots
Woodruff key slot milling cutters		Production of Woodruff key slot



Fly cutters		Used in experimental shops or tool rooms
Formed cutters		Used to generate irregular outline of work
Tap and reamer cutters		Intended for producing grooves or flutes in taps or reamers

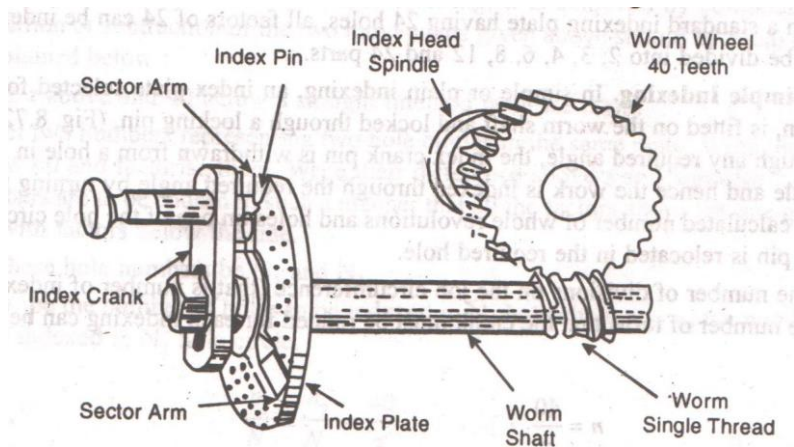
Q 5 ii) What is dividing head in gear cutting process? With neat sketch explain the construction of any one dividing head (Definition of dividing head 01 mark, Sketch 02 marks, construction 01 mark , any 01)

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;

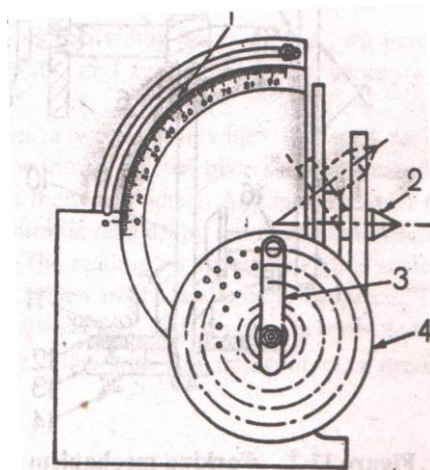
1. Plain or Simple dividing head

It comprises of a 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 rotate as one unit. Work is mounted at nose end of the spindle by chuck. Tail stock is separately bolted to the machine table.



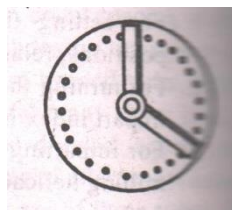
2. Universal dividing head

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



3. 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 circular 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 iii) Give the cutting parameters of milling operation (01 mark for each parameter)



Cutting speed in m/min or rpm

Feed per tooth

Feed per cutter revolution in mm/rev

Depth of cut in mm

Number of cutter teeth

Q 5 iv) Give the advantages and disadvantages of gear hobbing process (Any two advantages 01 mark each & Any two disadvantages 01 mark each)

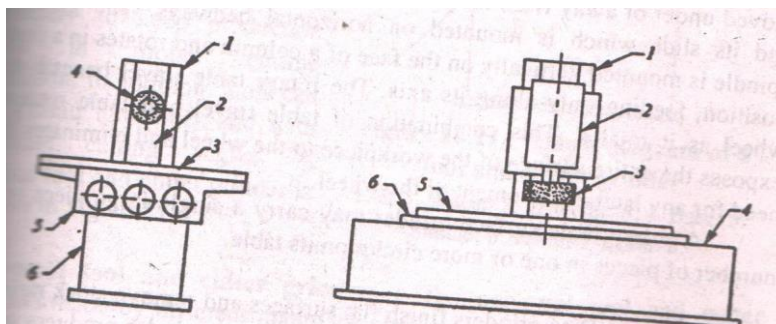
Advantages;

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 v) Sketch surface grinding machine and explain its working (Sketch 02 marks , Working 02 marks)



Surface grinding machines are employed to finish plane or flat surfaces. They are also capable of grinding irregular, curved, convex and concave surfaces. Conventional surface grinders are divided into two classes reciprocating table and rotary table. Also vertical or horizontal grinding wheel spindles. Grinding is normally done on the periphery of the wheel. The area of contact is small and the speed is uniform over the grinding surface while in vertical grinders area of contact is large and more material is removed.

Q 5 vi) What are the advantages and disadvantages of honing process. (Any two advantages 01 mark each & Any two disadvantages 01 mark each)

Advantages



1. High geometrical and dimensional accuracies are obtained
2. High surface finish is achieved.
3. Suitable for through as well as blind holes

Disadvantages

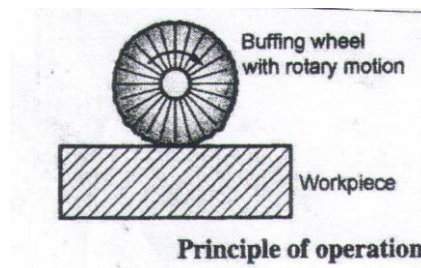
1. Construction of honing tool is complicated.
2. Relationship between different honing conditions.
3. Determination of honing pressure.

Q6) Answer any four of the following. (4*4 =16)

(02 marks for explanation and 02 for advantages)

Q 6 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.---

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

Advantages:-

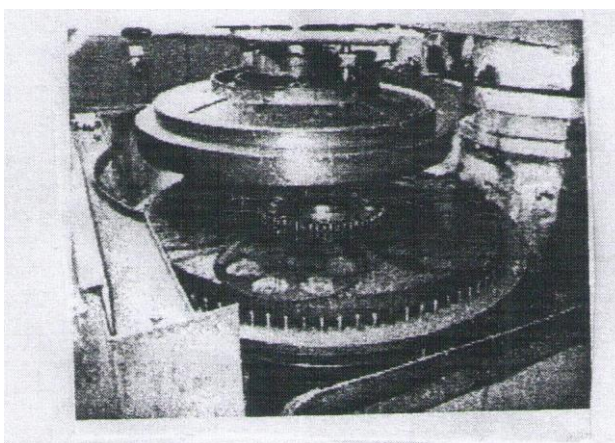
- 1) No surface preparation is required.
- 2) Suitable for ferrous/ non ferrous alloys.

Q. 6 ii) Machine lapping:-



(02 marks for sketch and 02 for explanation)

- It is preferred for finishing work in larger quantities and it is applicable for both flat and cylindrical lapping.
- Cylindrical work may be lapped by rotating the work in lathe or drill press and reciprocating the lap over the work in an everchanging path.
- Matched flat surfaces may be lapped by holding the work against the rotating disc, or work may be moved by hand in an irregular path over a stationary face plate lap.
- Types of lapping machines.—
 - 1) vertical axis lapping m/c
 - 2) centre less lapping m/c
 - 3) abrasive belt lapping.



- **Advantages—**
 - 1) No burrs are created.
 - 2) Any material hard or soft can be lapped.
 - 3) There is no warping of the lapped components.
- **Applications—**
 - 1) Precision plug gauges, slip gauges.
 - 2) Cylindrical valves and roller bearings.
 - 3) crankshaft, small engine pistons, small valve piston.
 - 4) piston rings, inner and outer bearing races etc.

Q. 6 iii) Types of maintenance:----(02 marks for list and 02 for explanation any one)

Basically two types of maintenances----

- 1) Unplanned maintenance-----
 - i) Breakdown maintenance
 - ii) Corrective maintenance
 - iii) Opportunistic maintenance
- 2) Planned maintenance-----
 - i) Preventive maintenance
 - ii) Predictive maintenance
 - iii) Corrective maintenance
 - iv) Routine maintenance
 - v) Design out maintenance
 - vi) Total productive maintenance.

Breakdown Maintenance---

- It is the conventional type of maintenance in which the breakdown of machine tool will occur and then maintenance is carried out to remove the faults.



- The basic concept of this maintenance is not to do anything until and unless the machine stops its function.
- It receives attention only after breakdown of machine tool for ex- belt is broken. Failure of Gears, couplings, springs, shafts.
- It is risky and provides no guarantee of reliable, smooth running of machine tools.
- It is good for small scale units where—
 - 1) No maintenance expert is available.
 - 2) sudden breakdown will not cause major loss.
 - 3) number of machine tools are few.
 - 4) no effect on production line directly due to small quantity production.

Q 6 iv) Maintenance practice of couplings and machine belts---- (04 marks)

- **1) coupling--** They are used to connect the shaft ends together for transmitting torque or rotary motion directly from one shaft to the other. The bearings are classified 1) Rigid coupling. 2) Flexible coupling. e.g.flanged coupling, muff coupling, bushed-pin coupling, and Oldham coupling.
- **Maintenance procedure of coupling---**
 - Due to misalignment , loose bolts etc abnormal noise comes out.
 - Observe the vibrations due to run out .
 - Visual inspection for misalignment, wear out parts.
 - Checking the lubrication regularly and change oil after certain interval.
 - Prepare maintenance report for showing history of maintenance of each coupling.

2)V-belt maintenance—

1. Entry of any metal particles , sawdust etc should be avoided otherwise it may cause abrasion of belt . Protection covers maybe provided at the top and side for this purpose.
2. Excess loading causes excessive stretching of belts. It should be avoided to reduce stretching of V belts.
3. V belts should be preserved free from conditions like heat , acids Which may cause damage to the rubber components.
4. Periodically check for slippage is to be carried out to ensure transmission of rated load .

Q 6 V) Repair complexity : (02 marks for explanation and 02 for utility)

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 decides 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.

Uses 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 vi) Maintenance Manual : (02 marks for explanation and 02 for contents)

- When purchase anew vehicle then maintenance booklet or service booklet is provided by manufacturer , called as maintenance manual.
- This booklet in printed format given the user of the equipment about the preventive maintenance to be done with respect to time scale of that machine tool .
- It is prepared on the vast experience of manufacturer and feedback collected from the customers who had used that type of machine tool already.
- It is a systematically maintenance of m/c tool in a right manner .
- Standardized maintenance procedure are adopted .

Contents of maintenance manuals

Maintenance manuals contents following things ----

- 1) safety precautions.
- 2) service center details.
- 3) procedure for maintenance of different parts one by one.
- 4) maintenance schedule for different parts.
- 5) instructions for safe handling.
- 6) important terms and abbreviations.

(if formats of the manuals given with explanation should be given full marks.)