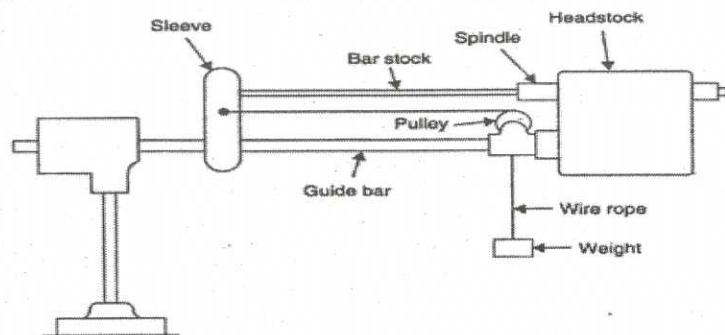


**SIXTH SEMESTER DIPLOMA EXAMINATION IN MECHANICAL
ENGINEERING/TECHNOLOGY**

ADVANCED PRODUCTION PROCESSES – Answer key

Marks

- I. 1) Straight cutter holder, Multiple cutter holder, Adjustable cutter holder, Roller steady, Knee tool holder, Knurling tool holder, Tap and die holder etc. ($\frac{1}{2} \times 4 = 2$)
- 2) Copying machines are used to produce the shapes from a larger or smaller template. Taper turning attachment in centre lathe is an example of a simple mechanical straight line copying device. ($2 \times 1 = 2$)
- 3) **Blanking:** Operation of cutting sheet to desired shape. Metal punched out is desired product and sheet with hole goes as waste. **Punching:** Operation of producing circular holes in a sheet metal using punch and die. The material punched out is removed as waste and sheet with hole is the required product. ($1 \times 2 = 2$)
- 4) Vitrified, Silicate, Resinoid or Bakelite, Shellac, Oxochloride, Rubber ($\frac{1}{2} \times 4 = 2$)
- 5) G code: Preparatory function or command; M code: Miscellaneous function or Machine function. ($1 \times 2 = 2$)
- II. 1) A guide bar is fixed to rear end of head stock. A rotating sleeve is mounted on the guide bar to carry the rear end of the bar stock. One end of the wire rope is tied to the sleeve and the other end carries a weight. When collet chuck opens, the bar is automatically pushed forward by weight and sleeve.

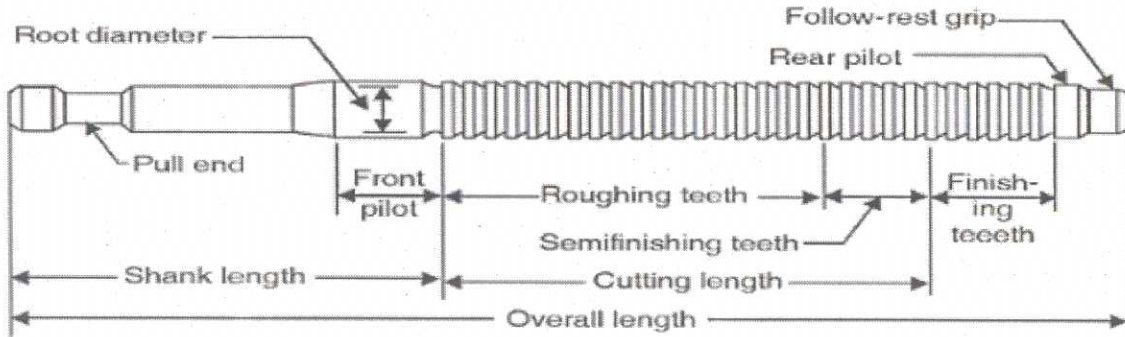


(Fig.3+ Exp3=6)

- 2)
- 1) Eliminates marking out and other setting of work piece before machining.
 - 2) Variability of dimension in mass production is very low. Parts produced maintains consistent quality.
 - 3) Due to low variability in dimension, assembly operation becomes easy, low rejection due to less defective products.
 - 4) The operating conditions like speed, feed rate and depth of cut can be set to higher values due to high clamping rigidity.
 - 5) Loading, unloading, handling time is less.
 - 6) Operators working becomes comfortable as handling operations are minimized. This saves labour cost
 - 7) Semi-skilled operators can be employed
 - 8) Reduces expenditure on the quality control of finished products.
 - 9) Process can be fully or partially automatized.
 - 10) It reduces overall machining cost.

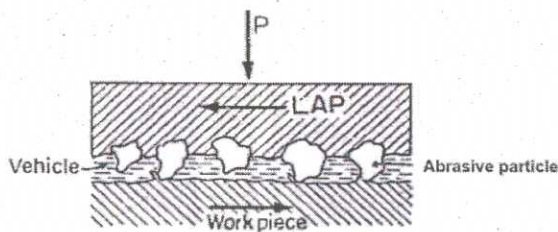
(1X6=6)

3)

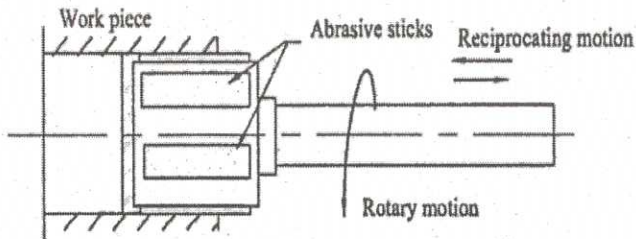


(Fig.3 + Parts3 =6)

4) Lapping is used to obtain high accuracy in size and to improve surface finish. The process consists of charging fine abrasive particle (Corundum, aluminum oxide, emery) b/w work piece and lap (soft cast iron, brass, bronze, copper, lead or soft steel) and are rubbed together. Abrasive is carried b/w work and lap by vehicle materials like vegetable oil, mineral oil, Grease etc.



Honing is an abrading or grinding process for finishing round holes, correct tool marks by means of bonded abrasive stones or stick called hone. Combined rotary and reciprocating motion of hones is given. Work piece does not perform any working motion. Coolant essential.



(3+3=6)

5) Advantages

1. No limit to cutting path as the laser point can move in any path
2. Very hard and abrasive material can be cut.
3. High accuracy parts can be machined
4. No cutting lubricants required
5. No tool wear
6. Narrow heat effected zone

Disadvantages

1. Initial cost is very high and lifespan of the flash lamp is short.
2. Limitations on thickness due to taper
3. High capital cost
4. High maintenance cost
5. Safety procedures are needed to be followed very strictly.
6. Too deep holes are not possible to drill
7. Overall efficiency is very low. (0.3 ~0.5 %)

(3+3=6)

- 6)
1. These machines can be used continuously and only need to be switched off for occasional maintenance.
 2. Increased productivity due to reduced set up and lead time
 3. Requires less skilled people to operate
 4. Complex shape can be machined easily and accurately at faster rate
 5. Greater flexibility. Changes in part design can be easily made through minor changes to part program
 6. Expensive jigs and fixtures are not required
 7. Can produce parts with high accuracy and close tolerances.
 8. Reduced scrap due to elimination of human error and high accuracy of these machines
 9. Reduced inspection requirements
 10. Uniformity and interchangeability of machined parts
 11. Greater safety as operator is not closely involved with actual machining operation
 12. Greater man power utilisation. Same operator can be used to monitor several NC machines at a time

(1x6=6)

- 7)
- a. Working conditions are dangerous and potentially hazardous to health
 - b. Working cycle is repetitive in nature
 - c. Work may be heavy or difficult to handle by human beings
 - d. Can lower costs, through reduction in usage of materials, through their efficiency and consistency.
 - e. More economical as labour costs increase
 - f. Flexible since they can be reprogrammed to perform different tasks
 - g. Do not have the limitations of human workers, such as fatigue, need for rest, diversion of attention, absenteeism, need for refreshments etc.
 - h. Perform tasks which human operators do not like to do- jobs that are considered unskilled, or low-paying or that involve poor working conditions.
 - i. Can be built with performance capabilities superior to those of human beings in terms of strength, size, speed, accuracy and repeatability.

(1x6=6)

III. a)

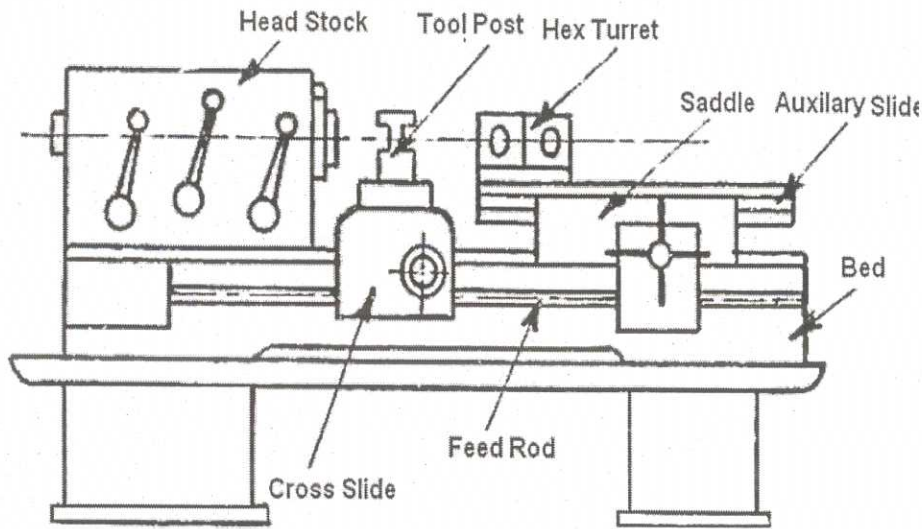
Bed: Long box like casting provided with accurate guideways on which headstock, carriage and turret saddles are mounted

Head stock: Large casting located at left hand end of the bed. Head stock is classified as: Electric motor driven headstock, all geared headstock, preoptive or preselective headstock.

Turret: It is a hexagonal shaped tool holder intended for holding six or more tools. Tool used in turret are drills, reamers, boring bar and cutting tools. For each tools, there is a stop screw to control the tool movement.

Turret saddle: This supports the ram (auxiliary slide) on which hexagonal turret is mounted. The saddle can be moved over the bed and clamped in any required position

Cross slide and carriage: Cross slide is mounted on the carriage. It is equipped with four way tool post at the front. One rear tool post at the back of the cross slide



(Fig 5 + Exp.4=9)

b)

SL No.	Single spindle	Multi spindle
1	There is only one spindle	There is 2,4,5,6 or 8 spindles
2	Only one work piece machined at a time	A number of work pieces can be machined at a time
3	Rate of production is low	Rate of production is high
4	Machining accuracy is higher	Machining accuracy is lower
5	Tool setting time is less	Tool setting time is more
6	Tool cost is less	Tooling cost is more
7	Economical for shorter as well as longer runs	Economical for longer runs only
8	Tool in turrets are indexed	Work piece held in spindles are indexed.

(1x6=6)

IV. a)

S.no	Capstan Lathe	Turret Lathe
1	It is a Light weight machine.	It is a heavy weight machine.
2	Turret head is mounted on the ram and the ram is mounted over the saddle.	Turret head is directly mounted on the saddle and saddle slides over the bed ways
3	For providing feed to the tool, ram is moved.	For providing feed to the tool, saddle is moved.
4	Length wise movement of turret is less	Length wise movement of turret is less
5	Short work pieces only can be machined	Long work piece can be machined
6	Its working operations are fast because of lighter in constructions.	Its working operations are slower because of heavier in constructions.

7	Heavy cuts on the workpiece cannot be given because of non-rigid construction.	Heavy cuts on the workpiece can be given because of rigid construction of machine.
8	It is easy to move turret head as it slides over ram	It is difficult to move turret head along with saddle.
9	The turret head cannot be moved cross wise	The turret head can be moved crosswise in some lathes.
10	Collet is used to grip the Job.	Power Jaw chuck is used to grip the Job.
11	Used for machining workpiece up to 60 mm diameter.	Used for machining workpiece up to 200mm diameter.
12	These are usually horizontal lathes.	Turret lathes are available in horizontal and vertical lathes.

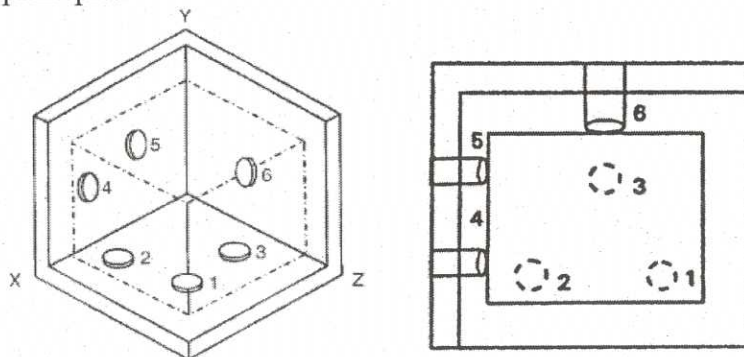
(1x8 = 8)

b)

1. Capable of handling wide variety of parts, size and shape efficiently, economically with high dimensional accuracy with tolerance in order of ± 0.0025 mm.
2. Versatile and capable of quick changeover from one type of product to another.
3. Time required to load and unload workpiece, changing tools, gauging of the part, and troubleshooting is reduced.
4. Productivity is improved thus reduced labour requirement and minimizing production costs.
5. These machines are equipped with tool condition monitoring devices for the detection of tool breakage and wear as well as probes for tool wear compensation and for tool positioning.
6. In process and post process gauging and inspection of machined work piece is possible.
7. Compact and highly automated and have advanced control systems, so one operator can attend to two or more machining centres at the same time

(1x7 = 7)

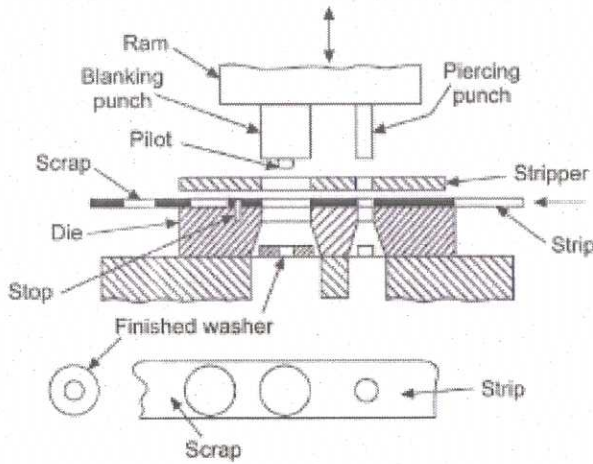
V. a) Pin 1, 2 and 3 at the base can restrict five motions. Two rotational movement along X and Z axes (4 motions). One movement along - Y axis (1 motion). Two pins positioned in vertical plane (X-Y) can restrict 3 motions. One movement along - Z axis (1 motion). Two Rotational movement along Y axis (2 motions). A single pin locator in vertical plane (Y-Z) restricts motion along - X axis (1 motion). Directions along + X axis, +Y axis and +Z axis restricted by a clamping device. (3 motions). This is called six Points location of a rectangular block or 3-2-1 principle.



(Fig. 3 + Exp 5 = 8)

b)

A progressive die has a series of stations. An operation is performed on the work piece at each station during the stroke of the press. In between the stroke intervals, the work piece is moved to next station. A progressive die is shown in figure. In the first stroke, a piercing punch cuts a hole in the stock. The strip is advanced for blanking operation in the second stroke to produce a washer. After that each stroke of the press produce a finished component.

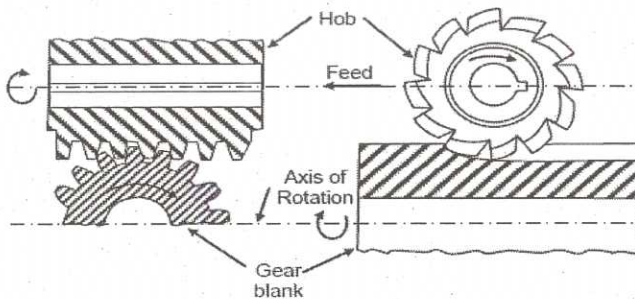


(Fig.4 + Exp 3 =7)

VI. a)

Principle

Hobbing is the process of generating a gear by means of a rotating cutter called hob. Hob resembles a worm gear. It has a number of flutes around its periphery, parallel to axis, to form cutting edges. The hob is rotated and fed against the rotating gear blank to generate the teeth.



Advantages

- A single hob with the given module can be used for generating gear with any number of teeth of same module.
- Operation is continuous so very fast rate of production
- The hob can be used for spur and helical gears
- Perfect tooth shape is obtained
- Process is automatic and hence less skilled operator is sufficient.
- Worm gears are generated only by hobbing.
- Multiple blanks can be cut at a time. Hence high rate of production.

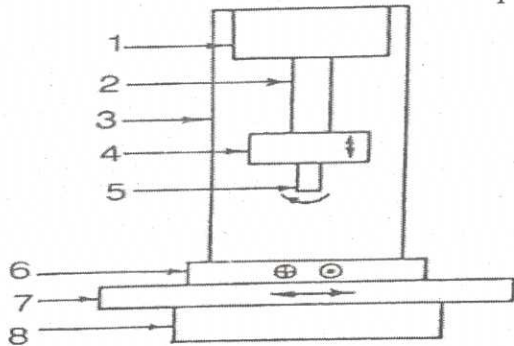
Limitations

- Internal gears cannot be generated
- Hobbing cannot be used for producing gear teeth very near to shoulders.
- Hob is complicated and expensive tool, requires careful regrinding

$$6 + \frac{1}{2} \times 4 = 8$$

b)

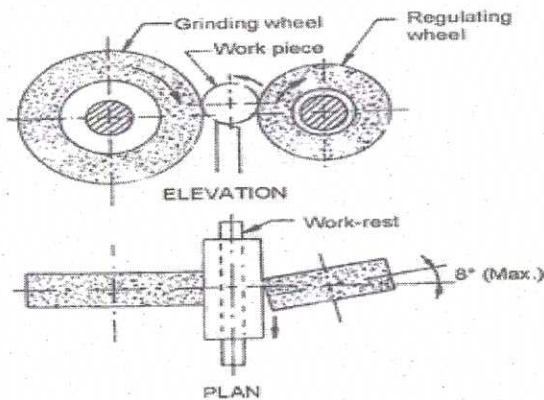
It is used for the production of jigs, fixtures, tools and other precision parts which requires high degree of accuracy. It consists of a heavy base and a column. Spindle head slides in the front of column guideways. The spindle moves inside a quill. Quill moves up and down inside the housing. Spindle runs in preloaded antifriction bearing. Saddle is mounted on the base. It gives cross feed to work. Table mounted on saddle provide longitudinal motion to work.



1. Spindle head, 2. Quill, 3. Column, 4. Spindle housing, 5. Spindle, 6. Table, 7. Saddle, 8. Bed.

(Fig 4 + Exp3 =7)

- VII. a) It is a method of grinding cylindrical surfaces without rotating the work piece between centres or chucks. The three components are grinding wheel, regulating wheel and the work rest. Both wheels rotate in same direction while the work piece rotates in the opposite direction. The work piece is supported on a work rest blade and is backed up by regulating wheel. Regulating wheel controls the speed of rotation of work piece and also the rate of feeding of work past the grinding wheel.



(Fig 4 + Exp.4=8)

b)

Natural abrasives: These are produced by uncontrolled forces of nature. Obtained from mines. E.g. Sand stone or solid quartz, Emery (50-60 % crystalline Al_2O_3 + iron oxide), Corundum (75- 90 % crystalline Al_2O_3 + iron oxide), Diamonds, Garnet

Artificial abrasives:

Silicon carbide (SiC): Ingredients: Silica sand 52%, Powdered coke 34 %, Common salt 2 %, Saw dust 12%. Used for grinding low tensile strength materials such as cemented carbide, ceramics, cast iron, brass, bronze, copper, aluminium etc. Denoted by letter C

Aluminum oxide (Al_2O_3): Obtained by melting aluminum hydroxide (bauxite ore) mixed with coke and iron chips in an electric furnace. Used for grinding materials of high tensile strength, such as most steels, carbon steel, HSS etc. Denoted by letter A.

Other artificial abrasives: Boron Carbide (B_4C), Zirconium oxide, Cubic boron nitride

(3+4=7)

VIII. a)

I. Constant factors

1. Material to be ground (This will influence selection of)

a. **Abrasive material:** SiC: - Suitable for low tensile strength material, Al₂O₃: - Suitable for high tensile strength material

b. **Grain size or grit number:** Coarse grain for soft and ductile material, fine grains for hard and brittle material

c. **Grade:** Hard wheel is used for soft material and soft wheel for hard materials

d. **structure:** Open: - soft and ductile, heavy cut; Dense: - hard and brittle material, finishing cut.

2. Amount of stock to be removed: Coarse grain for fast cutting and fine grain for fine finish. Wide spacing (open) for rapid removal and close (dense) for fine finish

3. Area of contact: Large area of contact, use coarser and softer wheel. Small area of contact, use finer and harder wheel

4. Condition of grinding machine: Heavy rigid machine, softer grade of wheel. Condition of machine such as to cause vibration harder grade is used.

II. Variable factors

1. Wheel speed: High wheel speed w.r.t work speed - soft wheel, Low wheel speed w.r.t work speed - hard wheel

2. Work speed: High work speed w.r.t wheel speed - hard wheel, Low work speed w.r.t wheel speed - soft wheel

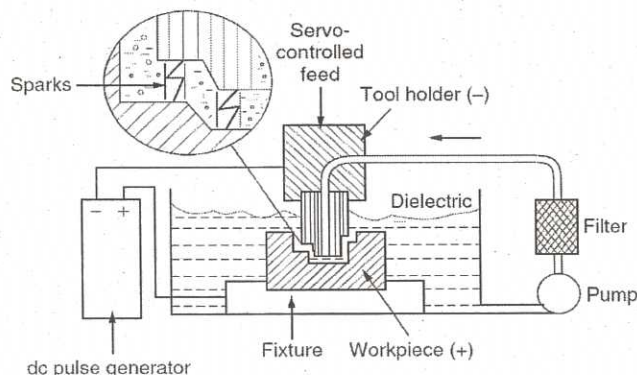
3. Condition of grinding: Dry condition – hard wheel, Wet condition – soft wheel

4. Skill of operator: Un skilled worker cannot handle soft wheels

(5+3=8)

b)

Heat energy of spark is used to remove material from the work piece. Work piece and tool should be electrically conductive. Tool is connected to the negative terminal (cathode) and the work piece is connected to positive terminal (anode). A very small gap is maintained between the tool and the work piece. Suitable dielectric slurry, which is a nonconductor of electricity is forced through this gap. When a proper DC voltage is applied (50 to 450 V), the dielectric breaks down and electrons are emitted from cathode (tool) and gap is ionized. When more electrons collect in the gap the resistance drop causing electric spark to jump between tool and work piece. Spark energy rises the localised temperature which melts and vapourises the work surface.



(Fig.3+Exp.4=7)

IX. (a)

1. According to the control system

- 1) Point to Point: Machining is done at specific position. The work piece remains unaffected as the tool moves from one position to next or vice versa. E.g.: Drilling machine
- 2) Straight line positioning: Straight line cut parallel to either X or Y axis can be programmed. Angular cut on work piece not possible. E.g.: Milling of slot or groove
- 3) Contouring positioning: Cutting takes place while position of tool and work piece are changing. E.g.: Various profiles, contours and curved surfaces

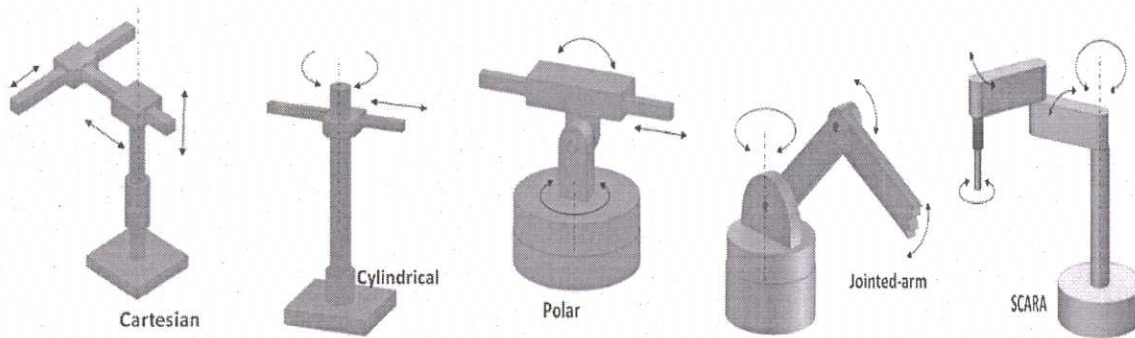
2. According to feedback system

- 1) Open loop: There is no feed back and hence no return signal to ensure that whether the tool has moved to correct position or not.
- 2) Closed loop: Monitors the actual position of tool. Feedback signal to control unit (MCU) indicates whether the tool has moved to correct position or not. If not, its position is automatically adjusted.

(4+4=8)

b)

1. **Cartesian/Rectilinear/X-Y-Z Robot:** Consists of three arms using sliding joints, Suited for straight-line and side-to-side movements. Used for pick and place work
2. **Cylindrical Configuration:** It consists of a vertical column that swivels. It has an arm assembly that can be moved up or down or in and out relative the column. Suited for movements around a base
3. **Polar/ spherical configuration:** It has three axes of motion that trace the shape of a sphere. It has a base unit that rotates, a main body that tilts, and arm that slides in and out.
4. **Joined arm/Revolute configuration:** It is similar to the configuration of a human arm. It has three axes of motion involving a base, a shoulder, and an elbow that rotate.
5. **SCARA ("Selective Compliance Assembly Robot Arm):** Similar in construction to the jointer-arm robot, except the shoulder and elbow rotational axes are vertical.



$(3 \frac{1}{2} \times 2 = 7)$

X. a)

FMS (Flexible Manufacturing System) is capable of processing a variety of different part styles simultaneously at the workstation and quantities of production can be adjusted in response to changing demand patterns. It is most suited for the mid variety, mid value production range.

The basic components of FMS are 1. Workstations, 2. Automated Material Handling and Storage system, 3. Computer Control System

Workstations consists of CNC machine tools, Machining centers, Load and unload station, Assembly work stations, Inspection stations etc.

Automated material handling systems consists of conveyers, automated guided vehicles (AGVs), industrial robots and other systems to carry parts between workstations, sometimes incorporating storage into function.

Computer Control System: Used to coordinate the activities of the processing stations and the material handling system. The various functions includes: Control of each work station, Distribution of control instruction to work station, Production control, Traffic control, Work handling system and monitoring, System performance monitoring and reporting.

(2+6 = 8)

b) **CAPP (Computer Aided Process Planning)** involves the automatic generation of a process plan (or route sheet) to manufacture the part. (CAPP) system reduces the routine clerical work of manufacturing engineers. Two alternative approaches to CAPP are Retrieval-type CAPP systems (also called variant systems) and Generative CAPP systems

Retrieval-type CAPP systems is based on group technology (GT) approach. In this approach, the parts produced in the plant are grouped into part families based on design or manufacturing similarities. For each part family, a standard process plans are made and stored using coding system. When process plan for a new component which belongs to that family is required, it can be retrieved and edited if necessary.

Generative type CAPP involves use of computer to create process plan for a new component automatically. In this system, process plans are created from information available in manufacturing data base without human assistance. In this retrieval is not involved. As the component features are input in the required way, the system itself prepares the process plan.

(2+2 $\frac{1}{2}$ x2 =7)