Important Instructions to examiners:

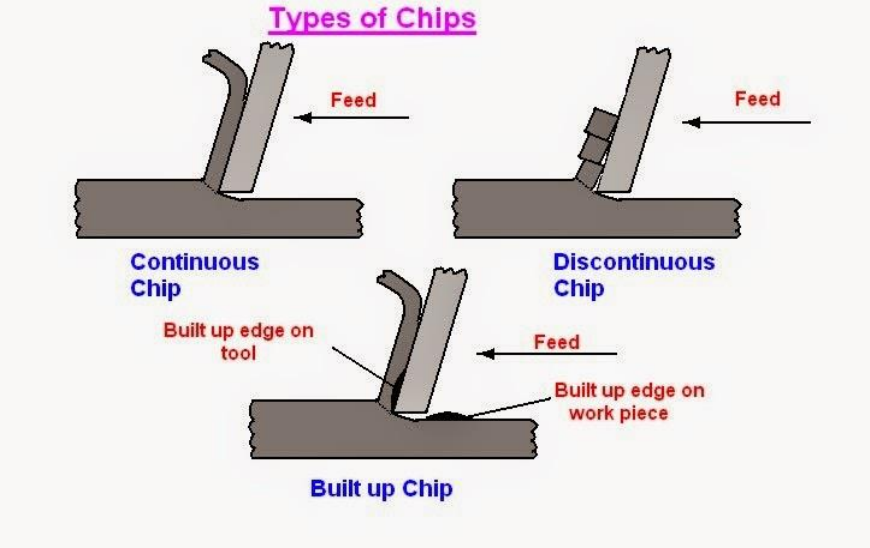
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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	Sub	Answer	marks
1	A a.	Attempt any THREE a) Enlist different types of chips. Explain in brief any one of them. Answer :- Types of Chips: 1. Continuous chip 2. Discontinuous chip 3. Continuous chip with built up edge. 1. Continuous chips: (Any one with fig -3) According to its name, continuous chips have a continuous segment. This chip is form during cutting of ductile material like aluminum, mild steal, cooper etc. with a high cutting speed. The friction between tool and material is minimum during this process. This is form due to continuous plastic deformation of the material by application of tool. These chips have equal thickness throughout the length. It generally gives good surface finish. The most favorable conditions of forming continuous chips are 1. Work piece should have ductile in nature. 2. The rack angle should be large. 3. Friction between work piece and tool should minimum. 4. Cutting speed should high. 5. Deft of cut should be small. 6. Proper use of coolant and lubricant. 7. Tool should have low coefficient of friction. Continuous chips are the most preferable type of chip due to following benefits. 1. It gives high surface finish of machining ductile material. 2. Continuous chips form when low friction which minimize friction loss. 3. Due to low friction, tool life is high 4. Power consumption is low. 2. Discontinuous chips or segmental chips: According to its name, this chips form in segment. It is form when machining of brittle material like cast iron, brass etc. with slow cutting speed. Chips cut into small segment during cutting. This is formed during slow cutting speed with small rack angle. This chips form in ductile material when the friction between tool and work piece is high. Discontinuous chips in ductile material give poor surface finish and slow machine. It is suitable form of chips of machining brittle material. The favorable conditions of forming this type of chip are 1. The work piece should have brittle in nature. 2. Slow speed of cutting	1 mark

3. Small rack angle of tool
4. Depth of cut should large

3. Continuous Chips with built up edge:

This type of chip is same as the continuous chips except a built edge is form at the face of tool. It is form during machining of ductile metal with excessive friction between tool and work piece. This chip is not smooth as continuous chips. The built up edge form due to high temperature between tool and work piece. This high temperature is due to high friction force between tool and work piece.



The common factors promoting built up edge are
1. Cutting of ductile metal.
2. High friction force at the face of tool.
3. High temperature between tool and work piece.
4. Lack of coolant and lubricant

b. b) What are different types of ceramic coating? State specifications of carbide tip.

Answer :- coating-3

1.Alumina-Titania based ceramics for wear, corrosion and variable texture surfacing.

2.Chrome-oxide ceramic coatings are extremely durable, ideal for seal surfaces.

3.Zirconia based ceramic are un-matched as thermal barrier and heat-shield coatings.

Specification-1 (Any TWO)

Actual Density g:
Hardness (Ra):
Abrasion resistance:
Transverse Rupture Strength
Tensile strength
Impact strength
Fracture toughness
Corrosion resistance
Total Binder %
Theoretical Density:
Young's modulus of elasticity
Poisson's ratio
Compressive strength
Fatigue strength

		Thermal Expansion coefficient Thermal conductivity Thermal capacity Magnetic coercive force Magnetic permeability Magnetic Saturation (Ms) Electrical Resistivity	
	c.	c) What is OBI press? State its specifications. Answer :- OBI Press-(02)	

Presses with gap frame are produced with solid frames in a vertical or inclined position. They are cut back in the form of letter "C" below the ram so that strip is fed from the side. Some presses have open-back so that strip is fed from front to back. A press is inclined so that the parts may fall through the open-back by gravity. Now-a-days, open-back inclination (OBI) is widely used for blanking and piercing operations on small workpieces.

The principle feature of gap frame machines is the C-shaped opening. For this reason, gap frame presses are also referred to as C-frame presses. In press force capacities up to approximately 250 tons (2,224 kn.) and larger, gap frame presses are less costly than a straight side press having the same force capacity and control features. In the 35 to 60-ton (311 to 534 kN) force range, they may cost approximately half as much as straight side press. The C-shaped throat opening has the advantage of permitting access to the die from three sides. This enables press working operations to be carried out on the corners and sides of large sheets of material. The open back is also accessible for discharging finished parts and scrap as well as feeding stock. The open accessibility from three sides facilitates quick die change with simple equipment.. The main disadvantage of gap frame presses is that there is an unavoidable angular misalignment that occurs under load. Limiting the amount of angular misalignment requires very robust construction, which adds to the weight and cost of the machine.

Specifications:- (02)

- Frame type
- Mechanism of delivering power to the ram (mechanical, electro-mechanical or hydraulic)
- Size of working area (e.g., 2500 x 1250 mm)
- Single or multiple station
- Force rating (for example, 20 tons)
- The type of tool shop and its capacity (e.g., store revolving type, capacity 34 tool)
- Speed or productivity (typically characterized by the speed of strokes with a step movement of 25 and 1 mm)
- Speed of movement without shock (speed-load displacement)
- Maximum weight of workpiece
- Safety features
- Power consumption
- The type of software

Punch presses are usually referred to by their tonnage and table size. In a production environment a 30-ton press is mostly the machine used today. The tonnage needed to cut and form the material is well known, so sizing tooling for a specific job is a fairly straightforward task. According to the requirement the tonnage may even go up to 2000 to 2500 ton presses.

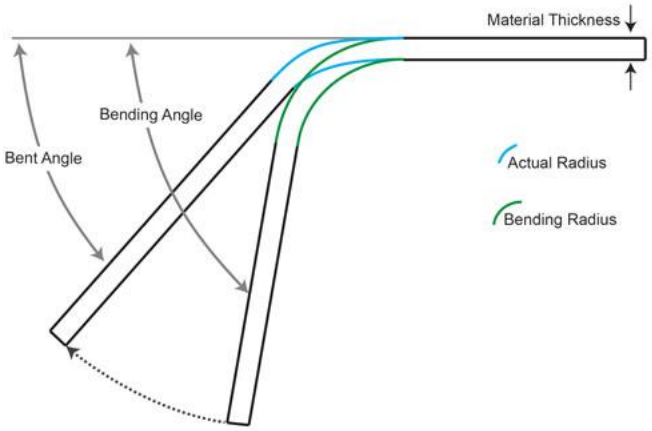
d. d) Explain the term 'Spring Back' 03

Answer :- In bending after the applied force is withdrawn the metal tries to resume its original position causing a decrease in bend angle. Such a metal movement is called spring back phenomenon. It is caused by the elastic stresses remaining in the bend area. After bending pressure on metal is released, the elastic stresses are also released, and cause metal movement. Spring back varies from ½ to 5° in steel whereas in phosphor bronze it may be 10-15 °.

Spring back depends upon the following factors:-

1. Material type
2. Thickness
3. Hardness
4. Bend radius

A larger bend radius causes greater spring back. Fig-01



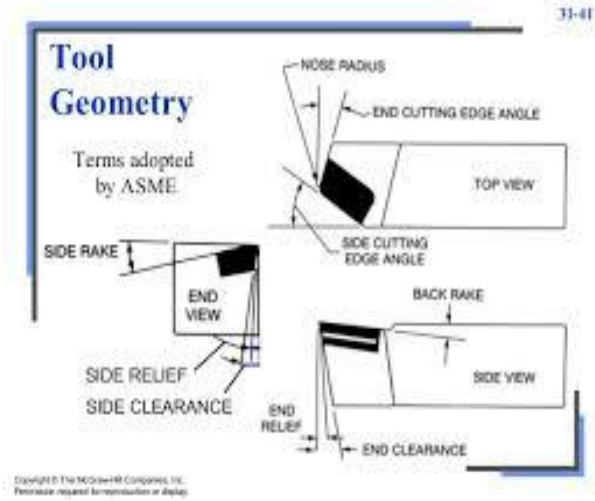
B. B) Attempt any ONE

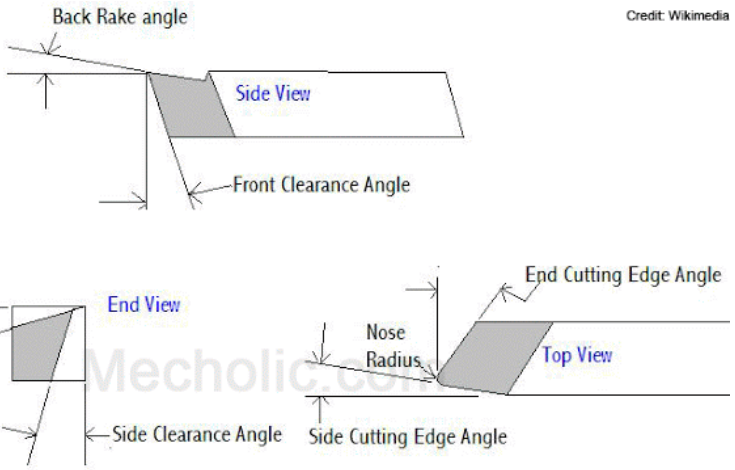
a. a) Explain with neat sketch the cutting tool geometry of single point cutting tool.

Answer:- Any one Sketch-03,Explanation-03

The shape and angle of tool face and cutting edge is known as tool geometry. Tool geometry depends on
Tool and work material

1. Cutting conditions – feed depth, and speed of cut.
2. Type of cutting
3. Required quality of cutting





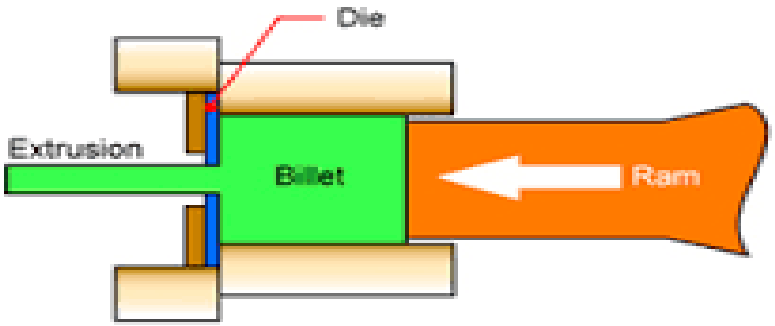
Credit: Wikimedia

Terms and definition

Cutting edge: Edge that contact with the workpiece during the cutting process.
The face of the tool: The surface over which chips flaw while cutting.
Flank: Surface below the cutting edge.
Shank: Lower parts of the tool.
Nose and nose radius: The nose is the junction where major and minor cutting edge meet. Smaller nose radii produce a smooth surface finish.
Lip angle: Angle between the top face and the end flank.
Back rake angle: The downward slope of the top surface of the tool from the nose of tool to the rear along the tool axis. It controls the direction of chip flow. Back rake angle may be positive, negative or neutral.
Side rake angle: The angle with which the top surface inclined sideways. It provides a clearance between tool and workpiece and prevents rubbing. Large side rake angle results in good surface finish.

Side relief angle: The angle between flank below the cutting edge and a line perpendicular the base of the tool. It is also known as side relief angle.
End relief angle: The angle between the end flank and plane normal to the base. Extra edge clearance is provided; it is also called clearance angle. Large end relief angle causes the breaking of cutting tool.
End cutting edge angle: The angle between end flank and a plane perpendicular to the side of

	b.	the shank. **Side cutting edge angle**: Angle between side cutting edge and the line extending from the shank (or a line parallel to the tool axis). b) Explain Metal Extrusion Dies. State its any two applications. Answer:- Explanation-05 Application-01 Metal extrusion is a metal forming process in which a work piece, of a certain length and cross section, is forced to flow through a die of a smaller cross sectional area, thus forming the work to the new cross section. The process begins by heating the stock material (for hot or warm extrusion). It is then loaded into the container in the press. A dummy block is placed behind it where the ram then presses on the material to push it out of the die. Afterward the extrusion is stretched in order to straighten it. If better properties are required then it may be heat treated or cold worked. The extrusion ratio is defined as the starting cross-sectional area divided by the cross-sectional area of the final extrusion. One of the main advantages of the extrusion process is that this ratio can be very large while still producing quality parts. **Hot extrusion** Hot extrusion is a hot working process, which means it is done above the material's recrystallization temperature to keep the material from work hardening and to make it easier to push the material through the die. Most hot extrusions are done on horizontal hydraulic presses that range from 230 to 11,000 metric tons (250 to 12,130 short tons). Pressures range from 30 to 700 MPa (4,400 to 101,500 psi), therefore lubrication is required, which can be oil or graphite for lower temperature extrusions, or glass powder for higher temperature extrusions. The biggest disadvantage of this process is its cost for machinery and its upkeep.[1] **Cold extrusion** Cold extrusion is done at room temperature or near room temperature. The advantages of this over hot extrusion are the lack of oxidation, higher strength due to cold working, closer tolerances, better surface finish, and fast extrusion speeds if the material is subject to hot shortness Materials that are commonly cold extruded include: lead, tin, aluminum, copper, zirconium, titanium, molybdenum, beryllium, vanadium, niobium, and steel. Examples of products produced by this process are: collapsible tubes, fire extinguisher cases, shock absorber cylinders and gear blanks. Wire drawing is related to extrusion but is used for smaller (round) sections and the metal is pulled through the die rather than pushed. Applications • Tubing • Aluminium window frames • railings • trims • wires	



2. Attempt any FOUR.

a. a) Define i) Chip thickness ratio

ii) Shear angle

Answer :- (02) Each

i) Chip thickness ratio :- It is the ratio of uncut or under formed chip thickness to chip thickness after the metal is cut.

$r = t / t_c$

ii) Shear angle :- It is defined as the angle made by the shear plane, with the direction of the tool travel. It is denoted by ¢.

b. b) Enlist different types of tool material. State at least one application of each.

Answer :- Types of tool material (any four Types-02,Application-02)

1. High carbon steel
2. High speed steel
3. Non ferrous cast alloys
4. Cemented Carbides
5. Diamond
6. Ceramics
7. Cubic boron nitride
8. UCON
9. Sialon

1. High Carbon Steel tools

- It is used for machining soft metals like free cutting steels and brass and used as chisels etc.

2. High speed steel (H.S.S)

H.S.S is used for drills, milling cutters, single point cutting tools, dies, reamers etc.

3. Non – ferrous cast alloys

Applications: Burnishing rollers, wear strips, hard facing of dies and gages , antifriction bearings exposed to high heat, used as a inserts.

4. Cemented carbides

		Applications:- used for wire drawing dies, long run blanking dies, mandrel gauges, boring bars , used for metal cutting **5. Ceramics and sintered oxides** ▪ Used for machining Carbon, low alloy steels, graphite, fiber glass. ▪ Used for roll turning, long tube boring, cylinder liner boring **6. Cermets** ▪ Applications: used in semi-finished and finished machining of low alloy steel, stainless steel, ductile iron and hard steel. **7. Diamond** . Diamond powder is used for grinding and polishing ii) Used as turning tools iii) Grinding dressers iv) inserts for wire drawing dies v) for turning of plastics, light metals and difficult to machine materials ▪ **8. Cubic Boron Nitride (CBN)** ▪ Consists of atoms of Nitrogen and Boron and produced by power metallurgy process. ▪ Used as a substitute for diamond during machining of steel. **9. UCON** used for roughing, semi roughing and finishing cuts in turning, facing and boring **10. Sialon (Si-Al-O-N)** ▪ At present this is used for machining of aerospace alloys, nickel based gas turbine blades with a cutting speed of 3 to 5 m/sec.	
	c.	Define the term Tool Life. Write tool life equation indicating each term. Answer:- Defination-02,Equation-02 Tool Life :- It is defined as the time elapsed between two successive grindings of the tool. During this period the tool cuts efficiently and effectively. Tool Life Equation $VT^n = C$ Where V = Cutting speed in metre/min T = Tool Life in minutes n= An index closely related to the cutting tool material C= Constant.	
	d.	d) Differentiate between compound die and combination die. Answer:- (Any Four-04) • Compound die two or more operations performed at one station while in combination die a cutting operation is combined with a bending or drawing operation. • Compound dies are more accurate than combination die. • Compound die are economical in mass production also. • e g cup shape product from compound die and washer type product from combination die	

	e.	e) List out the merits and demerits of open die forging over closed die forging. Answer:- Merits :- (any four 02marks) 1.Better fatigue resistance 2.Continuous grain flow 3.Finer grain size 4.Improved micro-structure 5.Increased strength 6.Less material waste 7.Longer part life 8.Reduced chance of voids 9.Valuable cost savings Demerits:-(any four 02marks) 1.Less control in determining grain flow, mechanical properties and dimensions. 2.Restricted to short run production 3.Poor material utilization 4.Restricted to simple shapes. 5.Difficulty to maintain close tolerance.	
	3.	Attempt any TWO	
	a.	a) What is tool wear? State types of tool wear. State factors affecting tool wear. Answer :- Tool Wear (02marks) During any machining process the tool is subjected to three distinct factors :forces, temperature and sliding action due to relative motion between tool and the workpiece. Due to these factors, the cutting tool will start giving unsatisfactory performance after some time. The unsatisfactory performance may involve: loss of dimensional accuracy, increased surface roughness, and increased power requirements etc. The unsatisfactory performance results from tool wear due to its continued use. Types of tool wear(02marks) 1. Flank wear 2. Crater wear	

3. Adhesion wear
4. Abrasion wear
5. Diffusion wear

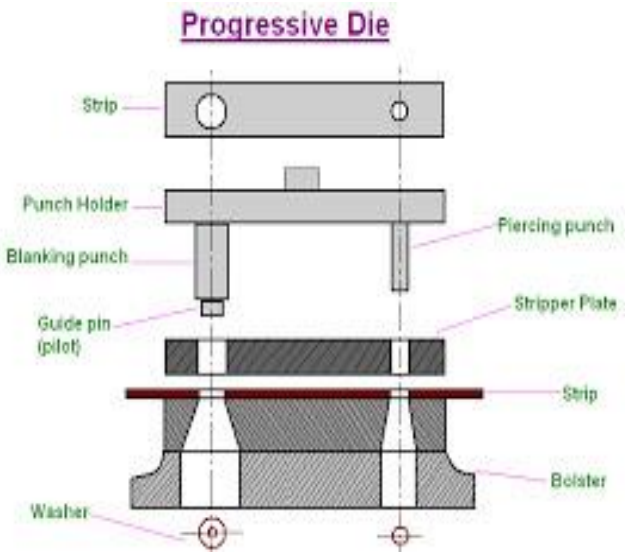
Factors :-(04marks)

1. Hardness and type of tool material
2. Type and condition of workpiece
3. Dimensions of cut
4. Tool geometry
5. Tool temperature
6. Surface finish and cutting fluid.

b. Explain with neat sketch process of making washer on progressive die.

Answer:- Explanation-04,sketch-04

A progressive die has a series of stations. At each station an operation is performed on a workpiece during a stroke of the press. Between stroke, the piece in the metal strip is transferred to the next station. A finished workpiece is made at each stroke of the press. While the piercing punch cuts a hole in the stock, the blanking punch blanks out a portion of the metal in which a hole had been pierced at a previous station. Thus after the first stroke, when only a hole will be punched, each stroke of the press produces a finished washer.



c. c) Determine the developed length of part shown in fig.

Answer:- While calculating the developed length for bending, external dimensions should be converted to internal dimensions.

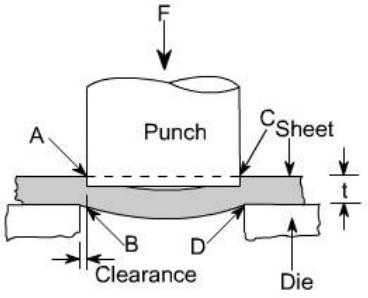
Developed length = L1 +L2 + B

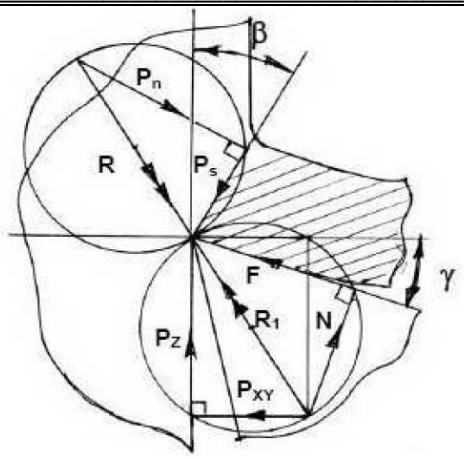
The inside radius of bend, r = 3.2 – 2.3 = 0.90 mm

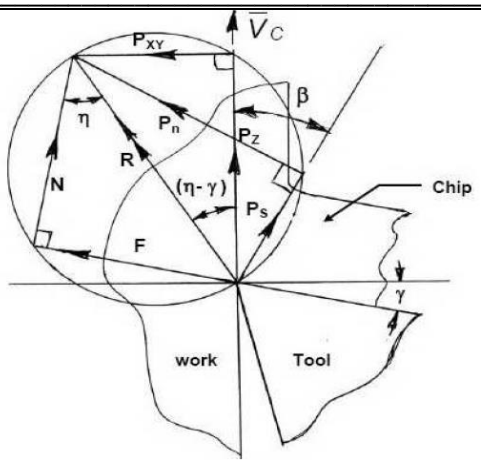
Length L1 = 76 – (2.3 + 0.90) = 72.8mm----------2M

Length L2 = 115 – (2.3 + 0.90) = 111.8 mm----------2M

		Bend allowance B = ∞/360 2∏(r + K) α = 90^0 K = t/3 B = 90/360.2∏ (0.90 + 2.3/3) = 2.61 mm----------2M Developed Length = 72.8 + 111.8 + 2.61 = **187.21 mm—2M**	
4	**A** **a.**	**Attempt any THREE.** **a) Types of cutting fluids** (any four) • **Compressed Air** • **Air with mist** • **Water Based Cutting Fluids** a) Water; b) Emulsions (soluble oil); c) Chemical solutions (or synthetic fluids); • **Neat Oils** a) Mineral oils; b) Fatty oils; c) Composed oils; d) Extreme pressure oils (EP); e) Multiple use oils. **Applications of cutting fluids** Cutting fluid may be applied to a cutting tool/workpiece interface through manual, flood or mist application. **Manual application** Simply consists of an operator using a container, such as an oil can, to apply cutting fluid to the cutting tool/workpiece. Although this is the easiest and least costly method of fluid application, it has limited use in machining operations and is often hampered by inconsistencies in application. **Flood application** Delivers fluid to the cutting tool/workpiece interface by means of a pipe, hose or nozzle system. Fluid is directed under pressure to the tool/workpiece interface in a manner that produces maximum results. Pressure, direction and shape of the fluid stream must be regulated in order to achieve optimum performance. **Mist Application** Cutting fluids may also be atomized and blown onto the tool/workpiece interface via mist application. This application method requires adequate ventilation to protect the machine tool operator. The pressure and direction of the mist stream are also crucial to the success of the application.	2 marks 2 marks
	b.	**Solution** $VT^n = C$ $V = 18$ m/min, $T = 3 \times 60 = 180$ mins, $C = 18 \times (180)^n$ Let n = 0.125 Therefore, $C = 18 \times (180)^{0.125} = 34.45$ …… 2m $V = 24$ m/min $VT^n = C$ $T = \{34.45/24\}^{(1/0.125)}$ ***T = 18 mins*** …… 2m	4 marks

	c.	**c) Strip layout and its stock layout influencing factors** **Strip layout** In the design of blanking die set, the first step is to prepare blanking layout that is to layout the position of the workpieces in the strip and their orientation with respect to one another. This is called as Strip layout. **Factors which influences the stock layout** Economy of material 1. Direction of material grain of Fibre 2. Strip or coiled stock 3. Direction of burr 4. Press used 5. Production required 6. Die cost	2 marks 2 marks
	d.	**d) Products manufactured** (any two products of each) 1. Pressure die casting: Lighting parts, Valve covers, Automotive parts, Aerospace parts, etc. 2. Forging dies: Connecting rod, Brake levers, Side stand, Screw drivers, etc.	4 marks
	B.	**Attempt any ONE.** **i) Solution** *K = 0.67, l = 900 mm, ϭut = 400 N/mm2, t = 3.2 mm*	
	a.	w = R1 + R2 + C = = 9.5 + 9.5 + 3.2 = 22.2 mm …… 2m $F = \frac{K.l.\sigma t.t^2}{w}$ …… 2m $F = \frac{0.67\ x\ 900\ x\ 400\ x\ 3.2^2}{22.2}$ $F = 111.25\ N$…….. 2m	6 marks
	b.	**ii) Clearance and its importance in shearing action** **Clearance:** The die opening should be sufficiently larger than the punch to permit a clean fracture of the metal. This difference in dimensions between the mating members of a die set is called clearance.  	3 marks
		Importance of clearance in shearing operation: The clearance between the punch and the die plays an important role in the determination of the shape and quality of the sheared edge. There is an optimum range for the clearance, which is 2 to 10% of the sheet thickness, for the best results. If the clearance increases beyond this, the material tends to be pulled into the die and the edges of the sheared zone become rougher.	3 marks
	5.	**Attempt any FOUR.** **a) Merchant's circle (any one sketch)**	
	a.		





(a) Development of Merchant's circle diagram (b) Cutting forces in MCD

(sketch 2m and explanation 2m)

The forces in the chip segment are:

- From job-side:
  Ps - Shear force.
  Pn - force normal to the shear force.
- From the tool side:
  R1 = R (in state of equilibrium)
  where, R1 = F + N
  N - Force normal to rake face.
  F - Friction force at chip tool interface.

The resulting cutting force R or R1 can be resolved further as,
R1 = PZ + PXY where, PZ - Force along the velocity vector.
PXY - force along orthogonal plane.
The circle(s) drawn taking R or R1 as diameter is called Merchant's circle which contains all the force components concerned as intercepts. The two circles with their forces are combined into one circle having all the forces contained in that as shown by the diagram called Merchant's Circle Diagram (MCD).

b. **b)** Comparison between Orthogonal and oblique cutting (any four points)

4marks

Sr. No.	Orthogonal Cutting	Oblique Cutting
1	Cutting edge of the tool is perpendicular to the direction of travel of the tool	Cutting edge is inclined at an angle with the normal to the direction of tool travel
2	Cutting edge clears the width of the w/p on either ends	Cutting edge may or may not clear the width of the w/p
3	The chip coils are tight and flat spiral	The chip flows side ways in a long curl
4	Only two components of the forces are acting on the tool	Three components of the forces acting
5	Maximum chip thickness occurs at the middle	Maximum chip thickness may not occur at middle

6	Due to smaller area of the tool, less friction in between work-tool interface therefore tool life is more	It acts on larger area and thus tool life is less	

c. **c) Factors affecting on tool life (any four)** — 4marks

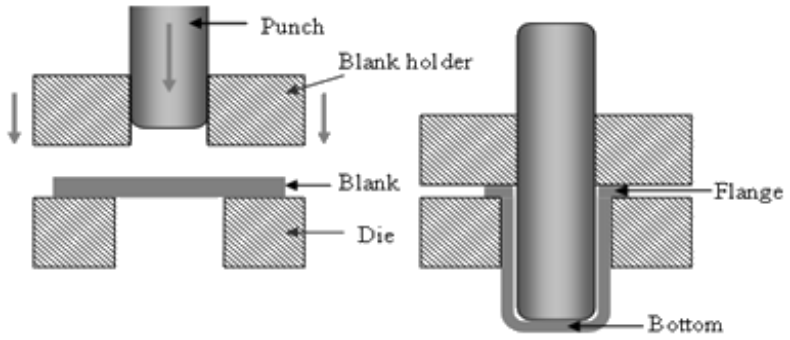
The life of the cutting tool is affected by the following factors:

1. Cutting speed.
2. Feed and depth of cut.
3. Tool geometry.
4. Tool material.
5. Cutting fluid.
6. Work piece material.
7. Rigidity of work, tool and machine.

d. **d) Press operations (any eight)** — 4marks

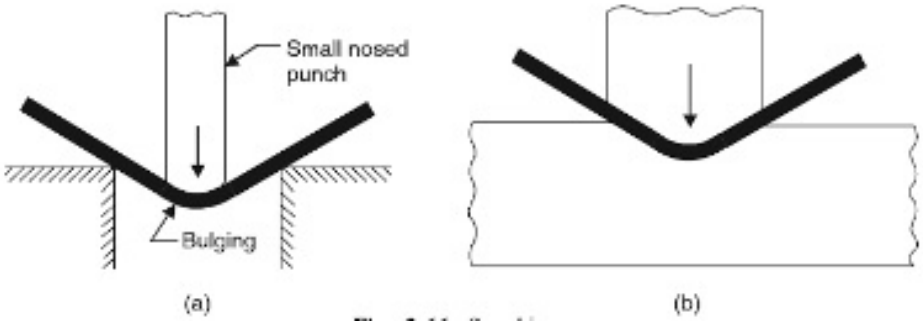
1. Blanking
2. Punching
3. Notching
4. Perforating
5. Trimming
6. Shaving
7. Slitting
8. Lancing
9. Nibbling
10. Bending
11. Drawing
12. Squeezing

e. **e)** Metal flow during drawing (Fig. 2m and explanation 2m) — 4marks



During drawing of sheet into the die, there is thickening of the sheet up to 12%. Therefore, clearance is provided between the punch and die. The radial clearance therefore is equal to the sheet thickness plus the thickening of sheet. Punch pushes the bottom of the sheet into the die cavity. The flat portion of the sheet under the holding plate moves towards the die axis, then bends over the die profile. After bending over the die profile the sheet unbends to flow downward along the side wall. The vertical portion of the sheet then slips past the die surface. More metal is drawn towards the center of the die in order to replace the metal that has already flown into the die wall. Friction between holding plate and blank and that between die and blank has to be overcome by the blank during its horizontal flow.

f. **f) Spanking (Fig. 2m and explanation 2m)**



4marks

During bending the area of the sheet under the punch has a tendency to low and form a bulge on the outer surface as shown in below figure a. This is prevented by having tool surfaces of sufficient area to restrain metal flow. Thus the nose radius of the punch is gradually blending in to the punch faces (figure b). The lower die should be provided with mating surfaces, so that when the punch and die are completely closed on the blank, any bulging developed earlier will be completely pressed or "spanked out'.

Attempt any TWO.

6.

a) Solution

t = f = 0.2 mm, t_c = 0.62 m and α = 15^0

a.

Chip thickness ratio (r) = $\frac{t}{tc} = \frac{0.2}{0.62} = 0.322$ …… 2m

Chip reduction coefficient = $\frac{1}{r} = \frac{1}{0.322} = 3.1$…… 2m

Shear angle = tan Ø = $\frac{\text{r} \cos \alpha}{1-\text{r} \sin \alpha} = \frac{0.322\ x\ 0.966}{1-0.322 \text{ x } 0.259}$

tan Ø = 0.3393

Shear angle Ø = 18.74^0…… 4m

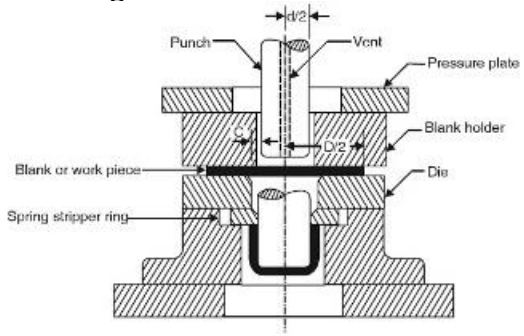
b) Functions of following components (2m each)

b.

1. Pressure pad- A pressure pad presses against the material during L bending or U bending, and is used for preventing the springing back of the material and the sliding of the material during forming. There is also the purpose of stripping off the material from the punch after forming.
2. Knock out – It is mechanism, usually connected to and operated by the press ram, for freeing a workpiece from a die.
3. Stock guide- The function of stock guide is as the name implies to guide and the stock through various stations.
4. Pilots- Pilots are used to guide in progressive dies. The piloting is achieved by means of pilots secured under the blanking punch, which engage the already pierced holes.

c) A simple push through drawing die

c.



(sketch 5m and explanation 3m)

A simple push through drawing die is shown in above figure. The drawing punch must be properly vented with drilled passages. Venting serves double purpose. It eliminates suction which would hold the cup on the punch and damage the cup when it is stripped from the punch. Thereafter, venting provides passages for lubricants.
