I Mid Term Solution
Sub: KOM

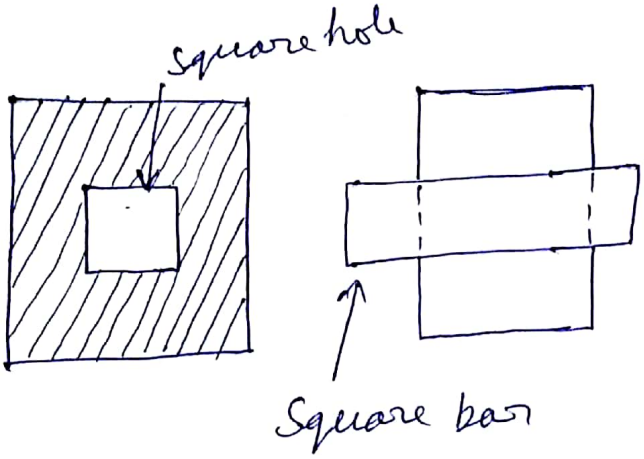
Q.1 What is kinematic Pair. Explain the types of Constrained motion.

Ans. Kinematic Pair: The two links or element of a machine, when in contact with each other, are said to form a pair. If relative motion between them is completely or successfully constrained (in a definite direction), the pair is known as Kinematic pair.

Types of Constrained motion: There are three types of constrained motion:-

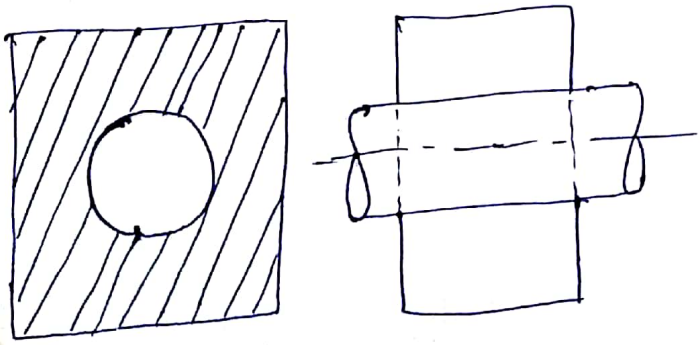
1. Completely constrained motion:- When the motion between the pair is limited to a definite direction irrespective of the direction of force applied, then the motion is said to be a completely constrained motion. For example piston and cylinder (in a steam engine) form a pair and the motion of the piston is limited to definite direction. The motion of square bar in a square hole and motion of a shaft with collars at

each end in a circular hole.

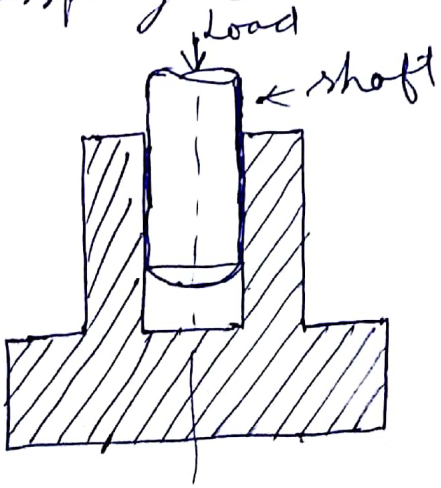


Square bar in a square hole

2. Incompletely Constrained motion :- When the motion between the pairs can take place in more than one direction, then motion is called an incompletely constrained motion. The changed in the direction of impressed force may alter the direction of relative motion between the pair. A circular bar or shaft in a circular hole is an example of incompletely constrained motion as it may either rotate or slide in a hole.



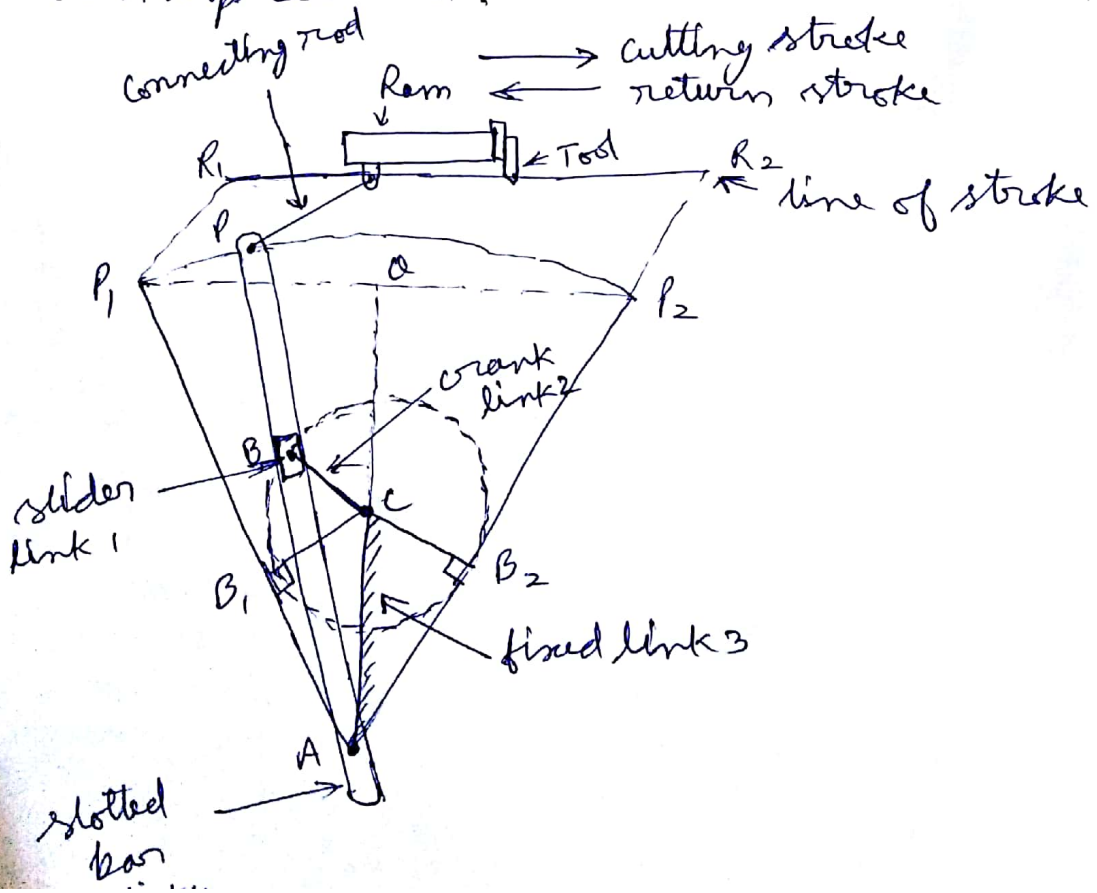
3 Successfully constrained motion: When the motion between the elements, forming a pair, is such that the constrained motion is not completed by itself, but by some other means, than the motion is said to be successfully constrained motion. Consider a shaft in a foot step bearing. The shaft may rotate in a bearing or it may move upwards. This is a case of incompletely constrained motion. But if the load is placed on the shaft to prevent axial upward movement of the shaft, then the motion of the pair is said to be successfully constrained.



Shaft in a foot step bearing.

Q.2 Describe the Quick Return mechanism with proper diagram.

Ans. In this mechanism, the link AC (link 3) forming the turning pair is fixed. The driving crank CB revolves with uniform angular speed about the fixed centre C. A sliding block attached to crank pin at B slides along slotted bar AP and thus causes AP to oscillate about fixed point A. A short link PR transmits the motion from AP to ram which carries the tool and reciprocates along the line of stroke R_1R_2. The line of stroke of ram R_1R_2 is perpendicular to AC produced.



In extreme positions, AP_1 and AP_2 are tangential to the circle and the cutting tool is at the end of the stroke. The forward or cutting stroke occurs when the crank rotates from the position CB_1 to CB_2 (or through an angle β) in the clockwise direction. The return stroke occurs when the crank rotates from the position CB_2 to CB_1 (or through angle α) in the clockwise direction. Since the crank has uniform angular speed, therefore

$$\frac{\text{Time of cutting stroke}}{\text{Time of return stroke}} = \frac{\beta}{\alpha} = \frac{\beta}{360-\alpha} \text{ or } \frac{360-\alpha}{\alpha}$$

Since the tool travels a distance of R_1R_2 during cutting and return stroke, therefore travel of the tool or length of stroke

$$= R_1R_2 = P_1P_2 = 2PQ = 2AP_1 \sin\angle P_1AQ$$

$$= 2AP_1 \sin\left(90-\frac{\alpha}{2}\right) = 2AP\cos\frac{\alpha}{2} \quad (\because AP_1 = AP)$$

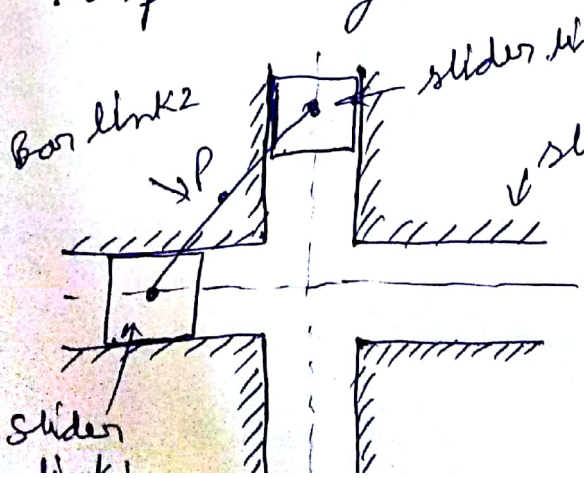
$$= 2AP \times \frac{CB_1}{AC} \quad \left(\because \cos\frac{\alpha}{2} = \frac{CB_1}{AC}\right)$$

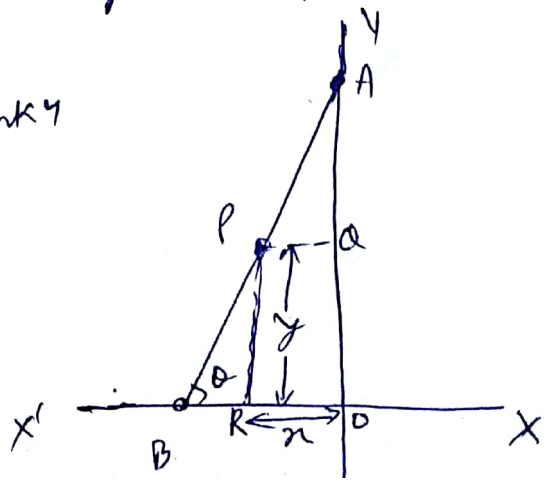
$$= 2AP \times \frac{CB}{AC} \quad (\because CB_1 = CB)$$

Q.3 Explain the working of Elliptical Trammel and prove that it traces ellipse.

Ans: It is an inversion used for drawing ellipse. This inversion is obtained by fixing link 4. The fixed plate or link 4 have two straight grooves cut in it at right angle to each other. The link 1 and 3 are known as slider and form sliding pair with link 4. The link AB link 2 is a bar which forms turning pair with links 1 and 3.

When the link 1 and 3 slide along their respective grooves, any point on link 2 such as P traces out an ellipse on the surface of link 4. A little consideration will show that AP and BP are the semi-major axis and semi-minor axis of the ~~ef~~ ellipse respectively. This can be proved ~~as~~





Let us take OX and OY as horizontal and vertical axes and let link BA is inclined at an angle θ with the horizontal. Now the Co-ordinates of point P on the link BA will be

$$x = PQ = AP\cos\theta; \text{ and } y = PR = BP\sin\theta$$

$$\Rightarrow \frac{x}{AP} = \cos\theta \quad \text{and} \quad \frac{y}{BP} = \sin\theta$$

Squaring and Adding

$$\frac{x^2}{(AP)^2} + \frac{y^2}{(BP)^2} = \cos^2\theta + \sin^2\theta = 1$$

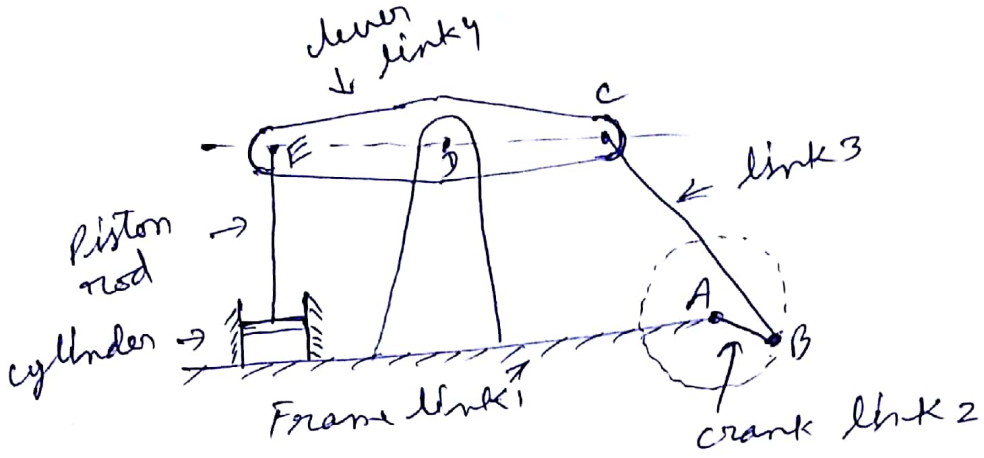
$$\Rightarrow \frac{x^2}{(AP)^2} + \frac{y^2}{(BP)^2} = 1$$

This is the equation of an ellipse.

Q.4 (i) Beam Engine:

Ans A part of a mechanism of a beam engine (also known as crank and lever mechanism) which consist of a four links is shown in figure below. In this mechanism when the crank rotates about the fixed centre D. The end E of the lever CDE is connected to a piston rod which reciprocates

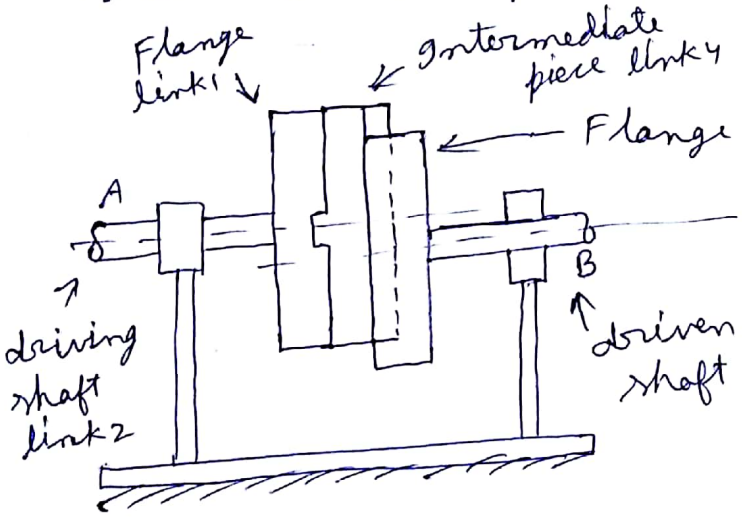
due to the rotation of the crank. In other words the purpose of this mechanism is to convert rotary motion in to reciprocating motion.

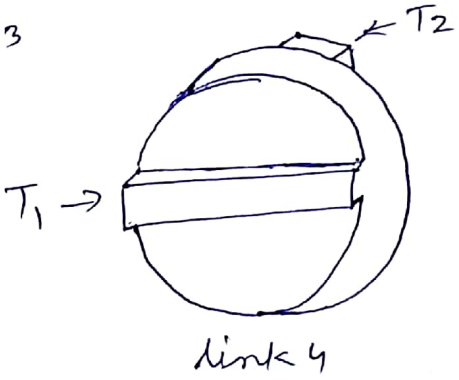


Beam Engine

(ii) Oldham's Coupling An oldham's coupling is used for connecting to parallel shafts whose axes are at small distance apart. The shaft are coupled in such a way that if one shaft rotates, the other shaft also rotates at the ~~same~~ same speed. This inversion is obtained by fixing link 2. The shaft to be connected have two flanges (link 1 and link 3) rigidly fastened at their ends by forging. The link 1 and link 3 from turning pairs with link 2. These flanges

have diametral slots cut in their inner faces. The intermediate piece link 4 which is a circular disc have two tongues T_1 and T_2 on each face at right angles to each other. The tongues on link 4 closely fit in to the slots in the two flanges (link 1 and link 3). The link 4 can slide or reciprocate in the slots in the flanges.





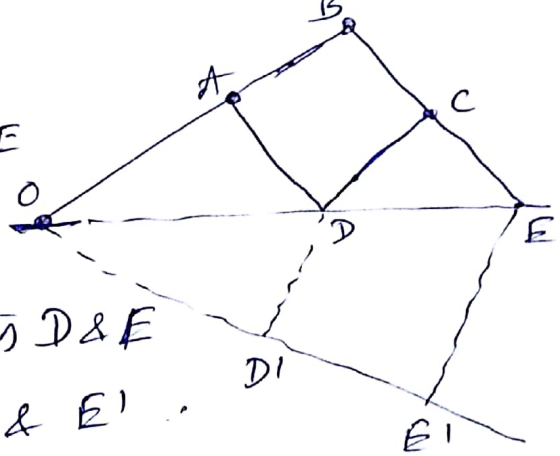
When the driving shaft A is rotated, the flange c link 1 causes the intermediate piece (link 4) to rotate at the same angle through which the flange has rotated, and further it rotates the flange D at the same angle and thus the shaft B rotates. Hence link 1, 3 and 4 have the same angular velocity at every instant.

Q.5 Explain the working of Pantograph.

Ans. A pantograph is an instrument used to reproduce to an enlarged or reduced scale and as exactly as possible the path described by given point. It consist of a jolned parallelogram ABCD as shown in figure. It is made up of a bars connected by turning pairs. The Bar BA and BC are extended to O and E respectively such that

$$\frac{OA}{OB} = \frac{AD}{BE}$$

Thus for all relative position of bar, the triangle OAD and OBE are similar and points O, D and E are in one straight line. It may be proved that point E traces out the same path as directed by point D.



From similar traiangle OAD & OBE

$$\frac{OD}{OE} = \frac{AD}{BE}$$

Let point O be fixed and points D & E move to some new position D' & E'.

Then

$$\frac{OD}{OE} = \frac{OD'}{OE'}$$

A little consideration will show that the straight line DD' is parallel to straight line EE'. Hence, if O is fixed to frame of a machine by means of a turning pair and D is attached to a point

JNIT

JAGANNATH GUPTA INSTITUTE OF ENGINEERING & TECHNOLOGY JAIPUR

I / II -MID TERM PAPER ANSWER SHEET

Semester: IV

Branch: Mechanical Engg.

Subject: Fluid Mechanics and Machines

Submitted by: Rakesh kumar-

Q.1 Define the following fluid properties:
Density, Weight Density and Specific Gravity?

Ans: Density ⇒ Density or Mass Density of a fluid is defined as the ratio of the mass of a fluid to its volume. Thus mass per unit volume of fluid is called density.

Unit of mass Density = kg/m^3 (SI unit)

$$\rho = \frac{\text{Mass of Fluid}}{\text{Volume of Fluid}}$$

The value of density of water is $1\ gm/cm^3 \Rightarrow 1000\ kg/m^3$

(ii) Weight Density ⇒ Specific Weight or Weight Density of a fluid is the ratio b/w the weight of fluid to it volume. Thus weight per unit volume of a fluid is called weight density

It is denoted by the symbol w.

$$w = \frac{\text{Weight of Fluid}}{\text{Volume of Fluid}} = \frac{(\text{mass of fluid}) \times \text{Acceleration due to gravity}}{\text{volume of Fluid}}$$

$$= \frac{\text{mass of Fluid} \times g}{\text{volume of Fluid}}$$

$$= \rho \times g$$

$$\boxed{w = \rho g}$$

Specific Gravity ⇒ It is defined as the ratio of the weight density of a fluid to the weight density of standard fluid. It is known as Specific gravity.

for liquid the standard fluid is taken water.

for gas the standard fluid is taken air.

It is denoted by symbol S

$$S = \frac{\text{Weight density of liquid}}{\text{weight density of water}}$$

$$S \text{ (for gas)} = \frac{\text{Weight density of gas}}{\text{Weight density of air}}$$

Ex: specific gravity of mercury is 13.6

hence density of mercury $= 13.6 \times 1000$

$= 13600 \text{ kg/m}^3$

Q.2 What do you mean by kinematic viscosity? Explain with their Dimensions.

Ans ⇒ It is defined as the ratio b/w the dynamic viscosity and density of fluid. It is denoted by the Greek symbol (ν) called 'nu'

$$\nu = \frac{\text{Viscosity of fluid}}{\text{Density of fluid}} = \frac{\mu}{\rho}$$

$$\nu = \frac{\mu}{\rho} = \frac{\text{force} \times \text{Time}}{(\text{Length})^2 \times \frac{\text{mass}}{(\text{Length})^3}}$$

$$= \frac{\text{force} \times \text{Time}}{\frac{\text{mass}}{\text{length}}}$$

$$= \frac{\text{Mass} \times \frac{\text{Length}}{(\text{Time})^2} \times \text{Time}}{\left(\frac{\text{mass}}{\text{length}}\right)}$$

$$= \frac{(\text{Length})^2}{\text{Time}}$$

So SI unit of kinematic viscosity is m^2/sec

One Stoke $= \frac{cm^2}{s} = \left(\frac{1}{100}\right)^2 m^2/s = 10^{-4} m^2/s$

Centistoke means $= \frac{1}{100}$ Stoke

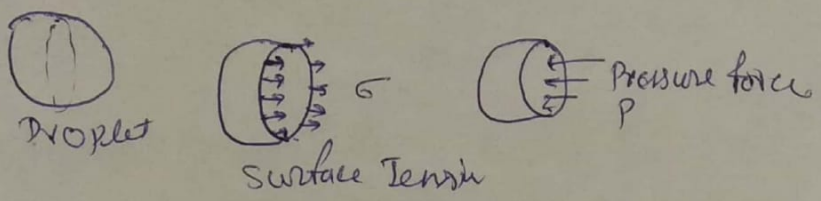
Q.3 Define Surface tension and derive the relationship b/w surface tension and pressure inside a droplet of diameter "d".

Ans ⇒) Consider a small spherical droplet of a liquid of radius 'r'. On the entire surface of the droplet the tensile force due to surface tension will be acting

σ = Surface tension of the liquid

p = Pressure intensity inside the droplet

d = Dia. of droplet.



(i) Tensile force due to surface tension acting around the circumference of the the cut portion.

$= \sigma \times$ circumference

$= \sigma \times \pi d$

(ii) Pressure force on the area =

$= p \times \frac{\pi}{4} d^2$

(iii) Thus two force will be equal and opposite under equilibrium condition

$$p \times \frac{\pi}{4} d^2 = \sigma \times \pi d$$

$$\boxed{p = \frac{4\sigma}{d}}$$

Q.4 Explain the following

(a) Laminar flow

(b) Turbulent Flow

(c) Steady Flow

Ans ⇒ Laminar flow ⇒ Laminar flow is defined as that type of flow in which the fluid particles move along well-defined paths or stream line and all the stream lines are straight and parallel. For a pipe flow the type of flow is determine by non-dimensional Number = $\frac{VD}{\nu}$ called the Reynold Number.

D = Diameter of pipe
V = Mean velocity of flow in pipe
ν = kinematic viscosity of fluid.

If Reynold Number is less than 2000 the flow is called laminar.

(b) Turbulent flow ⇒ Turbulent flow is that type of flow in which the fluid particles moves in a zig-zag way. Due to movement of fluid particles in a zig-zag way. If Reynold Number is more than 4000 it is called turbulent flow.

(c) Steady flow :- Steady flow is defined as that type of flow in which the fluid characteristics like velocity, pressure, density etc. at a point do not change with time. It is called steady flow.

$$\left(\frac{\partial V}{\partial t}\right)_{x_0 y_0 z_0} = 0 \qquad \left(\frac{\partial \rho}{\partial t}\right)_{x_0 y_0 z_0} = 0 \qquad \left(\frac{\partial p}{\partial t}\right)_{x_0 y_0 z_0} = 0$$

Q. 5. Find the surface tension in a soap bubble of 40mm diameter when the inside pressure is 2.5 N/m² above atmosphere.

Sol:- Dia of bubble $d = 40\text{mm} = 40 \times 10^{-3}\text{m}$

Pressure in excess of outside $p = 2.5\ \text{N/mm}^2$

Soap bubble $p = \frac{8\sigma}{d}$

$$2.5 = \frac{8 \times \sigma}{40 \times 10^{-3}}$$

$$\sigma = \frac{2.5 \times 40 \times 10^{-3}}{8}\ \text{N/m}$$

$$\sigma = 0.0125\ \text{N/m}$$ Ans

JNIT

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I / II -MID TERM PAPER ANSWER SHEET

Semester: IV Branch : Mechanical Engg.
Subject : MMT Submitted by : ROHIT SAXENA

Q1. What is meant by built-up edge (BUE)? Also explain the formation of a BUE.

Ans. When machining ductile materials, conditions of high local temperature and extreme pressure in the cutting zone and also high friction in the tool-chip interface may cause the work material to adhere or weld to the cutting edge of the tool forming the built-up edge.

Formation of BUE:

Successive layers of work material are added to the built-up edge. When this edge becomes larger and unstable, it breaks up and part of it is carried up the face of the tool along with the chip while the remainig is left over the surface being machined, which contributes to the roughness of the surface. The built-up edge changes its size during the cutting operation. It first increases, then decreases, then again increases etc.

This cycle is a source of vibration and poor surface finish. Although the BUE protects the cutting edge of the tool, it changes the geometry of the cutting tool.

Q2. What are the various basic tool angles? Explain the importance of all tool angles. Also draw the diagram to show all angles.

Sol: The various tool angles are defined as

(i) Side cutting Edge Angle (C_s): Side cutting edge angle (C_s) also known as lead angle, is the angle between the side cutting edge and the side of the tool shank.

Importance:

It is the angle which prevents interference as the tool enters the work materials. The tip of the tool is protected at the start of the cut, as it enables the tool to contact the work first behind the tip. This angle affects the tool life and surface finish.

(ii) End cutting Edge Angle (C_e): This is the angle between the end cutting edge and a line normal to the tool shank.

Importance:

This angle provides a clearance or relief to the trailing end of the cutting edge to prevent rubbing or drag between the machined surface and the trailing (non-cutting) part of the cutting edge. Only a small angle is sufficient for this purpose.

(iii) Side Relief Angle (θ_s):- It is the angle between the portion of the side flank immediately below the side cutting edge and a line perpendicular to the base of the tool and measured at right angle to the side flank.

(iv) End Relief Angle (θ_e):- It is the angle between the portion of the end flank immediately below the end cutting edge and a line perpendicular to the base of the tool and measured at right angle to the end flank.

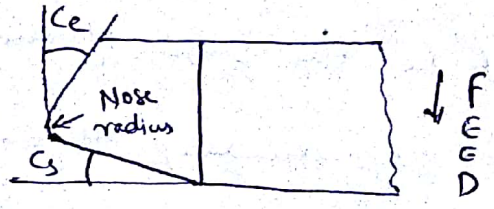
Importance:- These angles (θ_s and θ_e) are provided so that the flank of the tool clears the workpiece surface and there is no rubbing action between the two. Relief angles range from 5° to 15° for general turning.

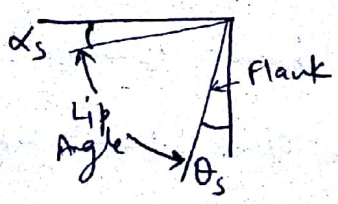
(v) Back-Rake Angle (α_b):- It is the angle between the face of the tool and a line parallel to the base of the tool and measured in a plane (perpendicular) through the side cutting edge. This angle is positive, if the side cutting edge slopes downwards from the point towards the shank and is negative if the slope of the side cutting edge

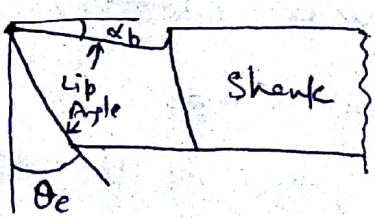
is reverse. So this angle gives the slope of the face of the tool from the nose towards the shank.

(vi) Side- Rake Angle (α_s):- It is the angle between the tool face and a line parallel to the base of the tool and measured in a plane perpendicular to the base and the side cutting edge. This angle gives the slope of the face of the tool from the cutting edge. The side rake is negative if the slope is towards the cutting edge and is positive if the slope is away from the cutting edge.

Importance:- The top face of the tool over which the chip flows is known as the rake face. The angle which this face makes with the normal to the machined surface at the cutting edge is known as "Back-rake angle, α_b", and the angle between the face and a plane parallel to the tool base and measured in a plane perpendicular to both the base of the tool holder and the side cutting edge, is known as "side-rake angle, α_s".







Q3. What do you mean by tool signature in ASA system? Explain tool-point reference system in brief.

Sol: The tool designation or tool signature, under ASA system is given in the order as

Back rake, side rake, End relief, side relief, End cutting edge, side cutting edge and nose radius that is,

$$\alpha_b - \alpha_s - \theta_e - \theta_s - C_e - C_s - R$$

If tool designation is:

$$8 - 14 - 6 - 6 - 6 - 15 - \frac{1}{8}$$, it means that,

$\alpha_b = 8'$ $\quad$ $\alpha_s = 14'$

$\theta_e = 6'$ $\quad$ $\theta_s = 6'$

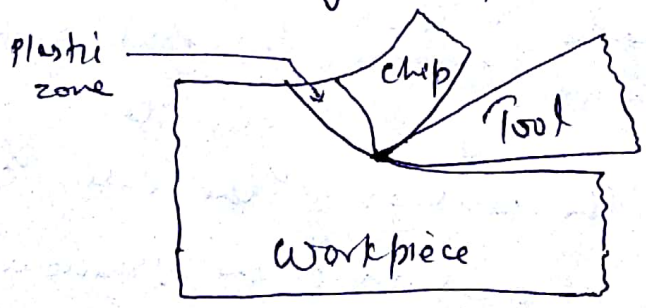
$C_e = 6'$ $\quad$ $C_s = 15'$

$R = \frac{1}{8}''$

Tool-point reference system: In ASA system of tool angles, the angles are specified independently of the position of the cutting edge. It, therefore, does not give any indication of the behaviour of the tool in practice. Therefore, in actual cutting operation, we should include the side cutting edge (principal cutting angle) in the scheme of reference planes. Such a system is known as Orthogonal rake system (ORS).

Q4 What do you mean by chip formation? What are the various types of chips involve in machining. Explain with diagram.

Sol: Chip formation: The metal is removed from the workpiece in the form of chips by the cutting tool. As the tool advances into the workpiece, the metal infront the tool is compressed and when the compression limit of the metal has been exceed, it is separated from the workpiece and flows plastically in the form of chip. The plastic flow of metal takes place in a localized region called shear plane, which extends from the cutting edge obliquely upto the uncut surface infront of the tool. The cutting tool causes shearing action bearing the metal along the plane.



Chip formation

Types of Chips

(i) Continuous Chips
(ii) Discontinuous chips
(iii) Built-up Chips
(iv) Serrated Chips.

Q5 Differentiate between orthogonal cutting and oblique cutting?

Sol.

Orthogonal Cutting	Oblique Cutting
(1) Cutting edge of the tool is perpendicular to the direction of tool travel	(1) Cutting edge of the tool is inclined at an angle with the normal to the direction of tool travel
(2) The cutting edge clears the width of the work piece on either ends.	(2) The cutting edge may or may not clear the width of the workpiece.
(3) The chip flows over the tool face and direction of chip flow velocity is normal to the cutting edge. The chip coils in a tight flat spiral.	(3) The chip flows on the tool face making an angle with the normal on the cutting edge. The chip flows sideways in a long curl.
(4) Only two components of the cutting force act on the tool. These two components are perpendicular to eachother and can be represented in a plane.	(4) Three components of the forces (mutually perpendicular) act at the cutting edge
(5) Maximum chip thickness occurs at its middle.	(5) The maximum chip thickness may not occur at middle
(6) Less tool life.	(6) More tool life.

Solution of 4ME4A - DME-I

Department → Mechanical Engineering.

Q1. Explain the following:-

a) Standardization

b) Interchangeability

a) Standardization:- It is defined as obligatory norms to which various characteristics of a product should comply with standards.

The characteristics include materials, dimensions and shape of the component method of testing and method of marking, packing and storing of the product

There are two words - "Standard and code" which are often used in standards.

A standard is defined as a set of specifications for parts, materials or processes. It's objective is to reduce the variety and limit the no. of items to reasonable level

A code is defined as a set of specifications for the analysis, design, manufacture, testing and erection of the product. The purpose of a code is to achieve a specified level of safety.

There are three types of standards used in designed office. They are as follows:-

(i) Company standards:- Used in a particular company or a group of sister components.

ii) National standards:-
- India - BIS (Bureau of Indian Standard)
- Germany - DIN (Deutsches Institute fur Normung)
- USA → AISI (American Iron and Steel Institute) or SAE (society of Automotive Engineers)
- UK → BS (British Standards)

iii) International Standards:- These are prepared by International Standard Organization (ISO).

(B) Interchangeability :- This term normally employed for the mass production of identical items within the prescribed limit of sizes. A little consideration will show that in order to maintain the sizes of the part within a close degree of accuracy, a lot of time is required. But even then there will be small variations. If the variations within certain limits, all parts of equivalent size will be equally fit for ~~obering~~ operating in machines and mechanisms. Therefore, certain variations are recognised and allowed in the size of the mating parts to give the required fitting. This facilitates to select random from a large number of parts for an assembly and results in a considerable saving in the cost of production. In order to control the size of finished parts with due allowance for error for interchangeable parts is called limit system.

Q2. A hole is dimensioned as $25^{\pm 0.03}$ mm and shaft is dimensioned as $25^{+0.00}_{-0.02}$ mm. What type of fit will be established? Determined also the maximum and minimum allowance of the fit, the hole and shaft Tolerance.

Ans:

hole → Max. → 25.03 mm
Min. → 24.97 mm

shaft → Max. → 25.00 mm
Min. → 24.98 mm

then, hole tolerance → ~~25.03 - 24.97~~ Max. limit − Min. limit

→ 25.03 − 24.97 = 0.06 mm

shaft tolerance → 25.00 − 24.98 = 0.02 mm

Max. allowance of the fit

↳ Max. dimension of the hole − Min. dimension of the shaft.

So, 25.03 − 24.98 = 0.05 mm (+ive allowance)

Min. allowance of the fit.

↳ Min. dimension of the hole − Max. dimension of the shaft.

24.97 − 25.00 = 0.03 (−ive allowance)

So, the type of fit is Transition fit.

Q3. What type of factors should be considered for the selection of material for the design of machine elements? Discuss each factor in short?

Ans: The selection of a proper material, for engineering purpose and for the machine component is one of the most important steps in the process of machine design. The best material is one which will serve the desired purpose at minimum cost.

It is always easy to select such a material and the process may involve the trial and error method.

The factors which should be considered while selecting the material for a machine component are as follows.

1.) Availability 2.) Cost 3.) Mechanical Properties

4.) Manufacturing Considerations.

1) Availability :-

- The material should be readily available in the market, in large enough quantities to meet the requirement.
- Cast iron and aluminium alloys are always available in abundance while shortage of lead and copper alloys is a common experience

2) Cost :-

- Cost for every application, there is a limiting cost beyond which the designer
- When the limit is exceeded, the designer has to consider other alternative materials
- In cost analysis, there are two factors, namely cost of material and cost of processing the material into finished goods.
- It is likely that the cost of material might be low, but the processing may involve costly manufacturing operations.

3) Mechanical properties :-

- It is the most important factor technical factor governing the material selection.
- They include strength under static and fluctuating loads, elasticity, plasticity, stiffness, resilience, toughness, ductility, malleability and hardness.
- Depending upon the conditions and the functional requirement, different mechanical properties are considered and a suitable material is selected.
- The piston rings should have a hard surface to resist wear due to rubbing action with the cylinder surface, and the surface hardness is the selection criterion.

- In bearing material case, a low coefficient of friction is desirable while clutch or brake requires a high coefficient of friction.

4) Manufacturing Consideration:-

- In some applications, machinability of material is an important consideration in selection.
- Sometimes, an expensive material is more economical than a low priced one, which is difficult to machine.
- Free cutting steels have excellent machinability, which is an important factor in their selection for high strength bolts, axles and shafts.
- Where the product is of complex shape, castability or ability of the molten metal to flow into intricate passage is the criterion of material selection.
- In fabricated assemblies of plates and jobs, Weldability becomes the governing factor.
- The manufacturing processes, such as casting, forging, extrusion welding and machining govern the selection of material.

Q.4. Explain the fits and give its classification in detail with suitable examples.

Ans:- The degree of tightness or looseness between the two mating parts is known as fit of the parts. The nature of fit is characterized by the presence and size of clearance and interference.

Clearance:- It is the difference between the sizes of the hole and the shaft before assembly. The difference must be +ive.

Interference:- The interference is the arithmetical difference between the sizes of the hole and the shaft, before assembly. The difference must be -ive.

Types of fits:-

According to Indian standards, the fits are classified into the following three groups:-

1) Clearance fit:- In this type of fit, the size limits for mating parts are so selected that clearance between them always occur. It may be noted that in a clearance fit, the tolerance zone of the hole is entirely above the tolerance zone of the shaft

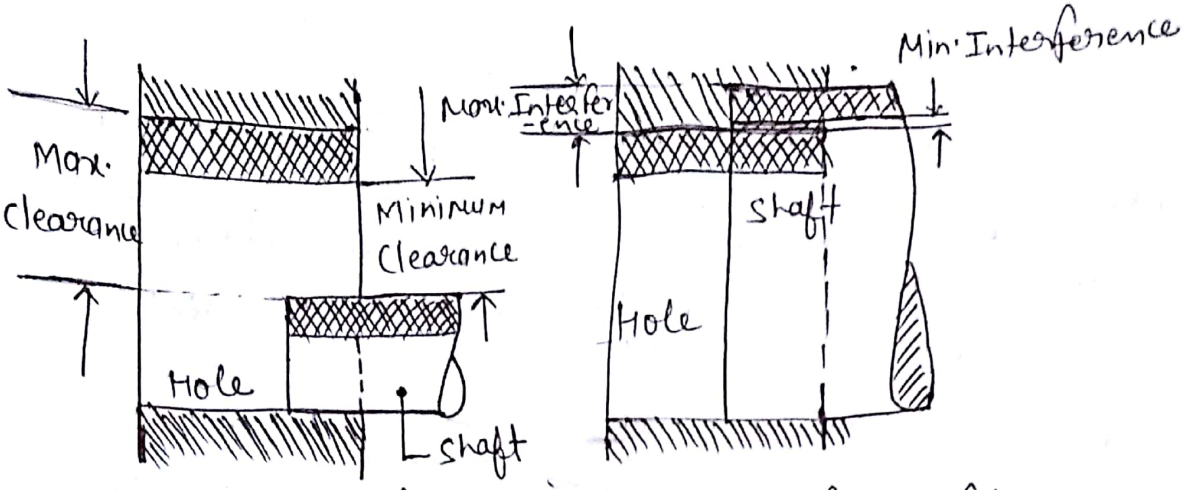
In a clearance fit, the difference between the minimum size of the hole and the maximum size of the shaft is known as minimum clearance Ex:- slide fit, running fit, loose running fit etc.

2) Interference fit:- In this type, the size limits for the mating parts are so selected that interference between them always occur. It may be noted that in an interference fit, the tolerance zone of shaft is entirely above the tolerance zone of the hole.

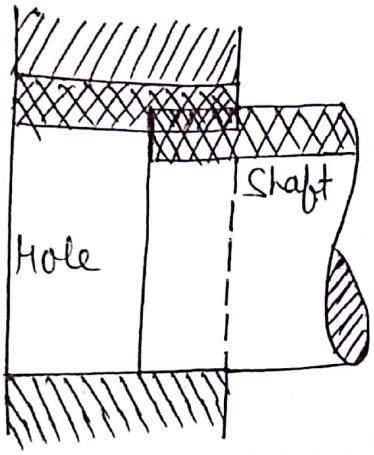
In this fit, the difference between the maximum size of the hole and the minimum size of the shaft is known as minimum interference, whereas the difference between the minimum size of the hole and the maximum size of the shaft is called maximum interference.

3) Transition fit:- In this type of fit, the size limits for the mating parts are so selected that either a clearance or interference may occur depending upon the actual size of the mating parts. It may be noted that in a transition fit, the tolerance zones of hole and shaft overlap.

Transition fit → force fit, tight fit, & push fit.



(a.) Clearance fit (b.) Interference fit



(c.) Transition fit

Q5. Define the limit and describe the limit system on the basis of hole and shaft system.

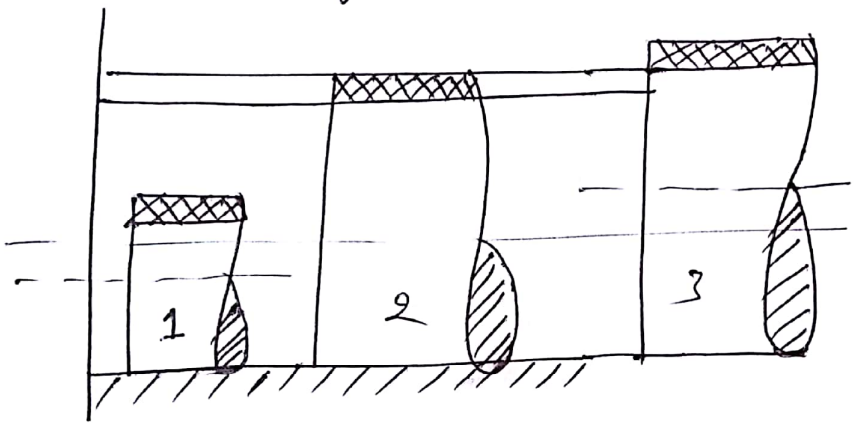
Limit → In mechanical engineering limit and fits are a set of rules regarding dimensions and tolerances of mating machined parts if they are to achieve the desired ease of assembly and security after assembly.

Following are two basis of limit system:-

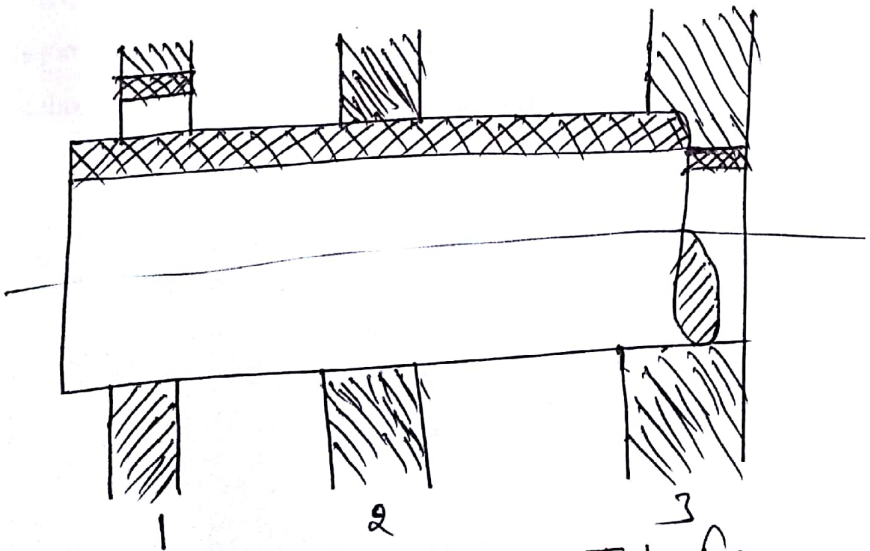
1.) Hole basis system:- when the hole is kept as a constant member and different fits are obtained by varying the shaft size then the limit system is said to be on a hole basis syst

2.) Shaft basis :- When shaft is kept as a constant member and different by varying the hole size, then the limit system is said to be on a shaft basis.

It may be noted that from the manufacturing point of view, a hole basis system is always preferred. This is because the holes are usually produced and finished by standard tooling like, drill, reamers etc, whose size is not adjustable easily. On the other hand the size of the shaft can be easily adjusted and is obtained by turning or grinding operations.



(a.) Hole basis system.



1 Clearance fit

2 Transition fit

3 Interference fit.

Shaft basis system.

UNIT 4ME5A: Industrial Engineering.

Q.1. Define Industrial Engineering. Explain the role of an industrial engineer.

Ans:- Industrial engineering is concerned with the design, improvement and installation of integrated system of man, materials and machines involved in production and distribution of products. It draws upon specialised knowledge and skills in the mathematical, physical sciences together with the principles and methods of engineering analysis and design to specify, predict and evaluate the results to be obtained from such systems. Following are the roles of industrial engg:-

→ An industrial engineer is responsible for site selection and development of a systematic layout for the smooth work flow without any interruptions.

→ To assist and aid in preparing a detailed job description, and job specification for each job and to evaluate them.

→ To assist and aid in developing the simplest work methods and establishing one best way of doing the work [standard method].

→ To assist and aid in developing a sound wage and incentive scheme.

→ To assist and aid in development of cost cost reduction & control programmes, and to establish standard costing system.

Q.2 :- What is work study? Explain in detail.

Ans :- Work study may be defined as the analysis of a job for the purpose of finding the prefered method of doing it and also determining the standard time to perform it by the prefered (or given) method. work study, therefore, comprises of two areas of study method study (motion study) and time study (work measurement).

In order to understand the role of work study we need to understand the role of method study and that of time study.

Method study is mostly used to improve the method of doing work. It is equally applicable to new jobs. when applied to existing jobs and existing jobs, method study aims to find better methods of doing the jobs that are economical and safe, require less human effort and need shorter make ready / put away time. The better method involves the optimum use of best materials and appropriate manpower so that work is performed in well organized manner leading to increased resource utilization, better quality and lower costs.

Time study, provides standard time. Standard times for different jobs are necessary for proper estimation of :-

→ manpower, machinery & equipment requirements
→ daily, weekly or monthly requirement of material

→ production cost per unit as an input to better make or buy decision.
→ labor budgets.
→ worker's efficiency and make incentive wage payments.

By the application of method study and time study in any organization, we can thus achieve greater output at less cost and of better quality and hence achieve higher productivity.

Q3. Explain the principle of motion economy.

Ans:- The principles of motion economy form a set of rules and suggestions to improve the manual work in manufacturing and reduce fatigue and unnecessary movements by the worker which can lead to the reduction in the work related trauma. The principles of motion economy can be classified into four groups:-

1. Principles related to the use of human body.
2. Principles related to the arrangement of the work place.
3. Principles related to the design of tools and equipment.

Use of Human Body:-

→ Continous curved vs. straight line motions.
→ Both hands should begin and end motion

[2] -

→ Both hand should not be idle, except during the rest periods.
→ The hand motions should be symmetrically and simultaneously away from/forward the body.

Design of workplace:-

→ Fixed locations for each tool & material, to eliminate search and select.
→ Gravity bins and drop delivery should be used to reduce reach and more times.
→ All materials and tools should be located within the normal working area.
→ These should be as close to the point of use as possible.
→ work table height should permit alternate sitting and standing posture.

Design of tools & equipment:-

→ Use proper coding of control devices to maxim
→ ~~Be~~ speed and minize error.
→ All levers, handles, wheels and other control devices should be located in most preferred area so as to use mechanical advantage.
→ Use jigs/finture to hold the part or raw materi-al.
→ Use stop guides to reduce the unnecessary manual controlled positioning.

Q4:- What is standard time and how it is calculated Explain.

Ans:- Standard time can be defined as the time taken by an average experienced worker for the job with provisions for delays beyond the worker's control.

Standard times for operations are useful for several applications in industry like,

→ estimating material, machinery and equipment requirements.

→ Estimating production cost per unit as an input to preparation of budgets, determination of selling price, make or buy decision.

→ Estimating manpower requirements.

→ Estimating delivery schedules and planning the work.

Calculation of Standard Time:-

Formulas used are-

Normal time = Observed time × Rating factor.

Standard time = Normal time + allowances.

Also, Representative time = $\frac{\text{mean}}{\text{mode of observed times}}$

Normal time = R.T. × $\frac{RF\ (in\ \%)}{100}$

Standard time = Normal time × (1 + fatigue Allowance Percentage)

Standard time = N.T. × $\frac{100}{(100 - FA\ \%)}$

[3].

Q5: Write a short note on scientific management theory

Ans:- Scientific management implies application of scientific methods and principles to the difficulties and questions that arise during the management of a business.

Also, in other words scientific management means use of scientific tools, such as definition, analysis, measurement, experimentation and proof in dealing with problems of management. Thus, Scientific management may be defined as the

"Art of knowing exactly what is to be done and the best way of doing it."

F.W. Taylor was a pioneer in propounding scientific principles of management as a result of his research in various areas of industrial activity. He was called as the "father of scientific Management". His contribution were as follows:-

→ Development of science for work.
→ Scientific selection, placement & training of workers.
→ Division of labours.
→ Standardization in production.
→ Use of time & motion study.
→ wage system differentiation.
→ Labour management.
→ Economy & profits.

JNIT

JAGANNATH GUPTA INSTITUTE OF ENGINEERING & TECHNOLOGY JAIPUR

I / II -MID TERM PAPER ANSWER SHEET

Semester: IV Sem Branch : mechanical engg.

Subject : ICE Submitted by : KUNAL SHARMA

Q1- A four cylinder four stroke petrol engine develops 14.7 KW at 1000 rpm. The mean effective pressure is 5.5 bar. Calculate the bore and stroke of the engine, if the length of stroke is 1.5 times the bore?

Ans. Number of cylinder n = 4

Power developed P = 14.7 KW

Engine speed N = 1000 rpm

Indicated mean effective pressure

imep = 5.5 bar

Length of stroke L = 1.5D (bore)

For four stroke cycle K = 1/2

L = ? D = ?

Indicated power developed

$$I.P = \frac{n \times imep \times LAN \times K}{60} \text{ KW}$$

$$14.7 = \frac{4 \times 5.5 \times 1.5D \times \frac{\pi}{4} D^2 \times 1000 \times \frac{1}{2} \times 10}{60}$$

$$D^3 = \frac{14.7 \times 6 \times 4 \times 2}{4 \times 5.5 \times 1.5 \times \pi \times 1000 \times 10} = 0.000686 \text{ m}$$

$$D = 0.0879 \text{ or } 87.9 \text{ mm}$$

$$L = 1.5 \times 87.9 = 131.8 \text{ mm}$$

(02) The following data refer to a single cylinder four stroke diesel engine:

(1) BP = 120 KW (2) Speed = 500 rpm (3) Bmep = 850 KPa
(4) BSFC = 0.335 kg/KWh (5) Calorific Value = 43500 KJ/kg
(6) L/d = 1.25 (7) mechanical efficiency = 80%.

calculate the bore and stroke length, nbth, imep and indicated thermal efficiency?

Ans:

$bp = K \cdot bmep \cdot LAn$ $\quad \therefore n = \frac{N}{2}$

$bp = 1 \times 850 \times 1.25D \times \frac{\pi D^2}{4} \times \frac{N}{2}$

$120 = 850 \times \frac{1.25 D^3}{4} \times \frac{\pi N}{2}$

$120 = \frac{850}{8} \times 1.25 D^3 \times 3.14 \times \frac{500}{60}$

$D^3 = 0.03452 m$

$D = 0.33 m$

$D = 330 mm$

$L = 1.25D = 1.25 \times 330 = 412.5 mm$

$\eta_{bth} = \frac{3600}{bsfc \times CV} = \frac{3600}{0.335 \times 43500}$

$= 0.247$

$= 24.7\%$

$\eta_{mech} = \frac{bp}{ip} = \frac{120}{ip} = 0.8$

$ip = 150 KW$

$150 = K \times imep \times 0.4125 \times \frac{\pi}{4}(0.33)^2 \times \frac{500}{2 \times 60}$

[imep = 1021 kPa]

$$\eta_{ith} = \frac{3600}{\frac{\dot{m}_f \times CV}{ip}}$$

$\dot{m}_f = bp \times bsfc = 120 \times 0.335 = 40.2$ kg/h

$$\eta_{ith} = \frac{3600}{\frac{40.2}{150} \times 43500} = 0.3088 = 30.88\%$$

(Q3) - Distinguish between two stroke and four stroke engine -

(Ans.)

	Two stroke	Four stroke
(1)	The cycle is completed in two strokes of the piston or in one revolution of the crankshaft. Thus one power stroke is obtained in each revolution of the crankshaft.	The cycle is completed in four stroke of the piston or in two revolution of the crankshaft. Thus one power stroke is obtained in every two revolutions of the crankshaft.
(2)	more uniform turning movement and hence lighter flywheel is needed.	Because of the above turning movement is not so uniform and hence heavier flywheel is needed.
(3)	Volumetric efficiency is less due to lesser time for induction.	Volumetric efficiency is more due to more time of induction.

(Q4). Distinguish between SI and CI engine.

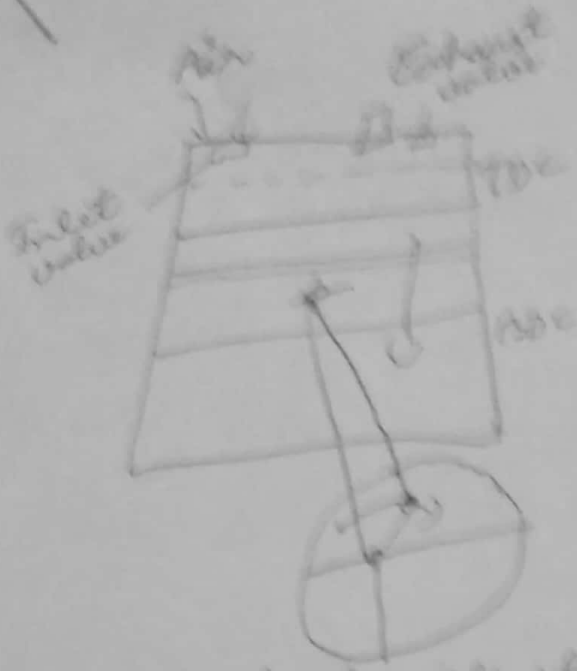
Ans.

	SI	CI
(1)	otto cycle	Diesel cycle
(2)	Petrol fuel is used.	Diesel fuel is used.
(3)	Air fuel ratio 10:1 to 20:1	18:1 to 100:1
(4)	combustion spark ignition	Compression ignition.
(5)	Calorific value 44 MJ/kg	42 MJ/kg
(6)	cost of running is high.	low
(7)	Initial capital cost is low	High due to heavy weight.

(Q5). Describe the working principle of SI Engine.

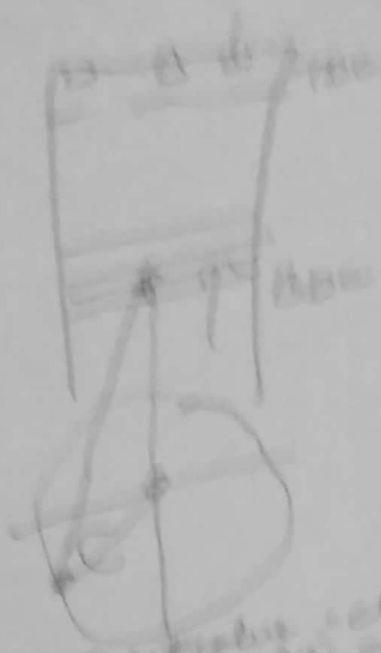
Ans. The working principle of SI Engine are:-

(1) Suction stroke → During this stroke, the inlet valve is kept opened and the exhaust valve is closed. The pistor comes down to the bottom dead centre (BDC) from the top dead centre (TDC). Pressure in the cylinder will be slightly less than the atmospheric pressure.



Inlet valve : open
Exhaust valve : closed

(a) Suction stroke

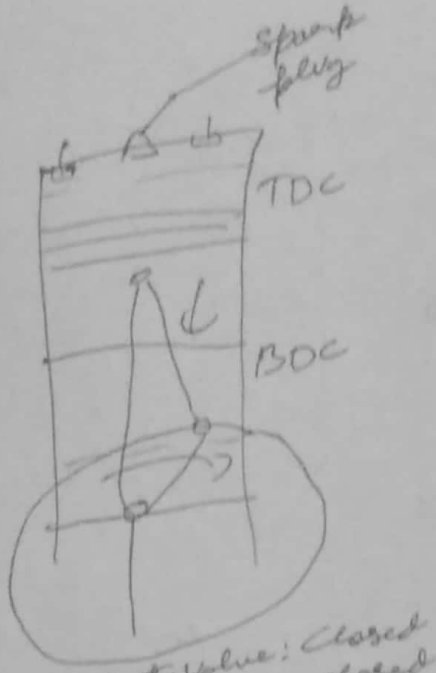


(b) Compression stroke

(2) Compression stroke → In this stroke both the inlet and exhaust valve are kept closed. The mixture of petrol-air is compressed when the piston moves up to TDC. The compression ratio varies from 7 to 10 for petrol engines.

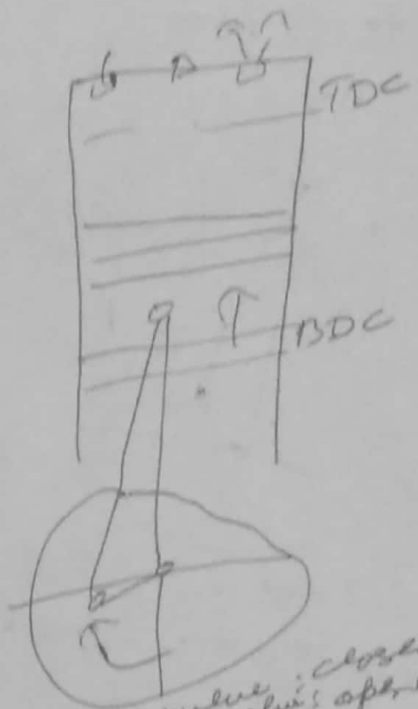
(3) Working or power stroke → During this stroke both valves are kept closed. The piston is pushed down from TDC to BDC.

(4) Exhaust Stroke → During the stroke, the exhaust valve is kept opened and the inlet valve is kept closed. The piston moves up from BDC to TDC. The waste gases are expelled out through the exhaust valve and the cycle is repeated.



Inlet valve: closed
Exhaust valve: closed

(c) Power Stroke



Inlet valve: closed
Exhaust valve: opened

(d) Exhaust Stroke