KSU CET

S1 & S2 Notes

2019 Scheme

KSU CET

Manifest the leadership in you

PART II: BASIC MECHANICAL ENGINEERING

(2019 Scheme)

Max. Marks:50 Duration: 90 min

PART A

Answer all questions, each carries 4 marks.

12	With the help of a block diagram explain the fuel system of CI engines.	(4)
13	What is meant by priming of a pump? Why is it necessary in a centrifugal pump?	(4)
14	Why gear drives are called positive drives, Whereas belt and rope drives are not considered positive?	(4)
15	Compare CAD and CAM.	(4)
16	Explain the advantages and disadvantages of rapid manufacturing systems.	(4)

PART B

Answer one full question from each module, each question carries 10 marks

Module-IV

17		Calculate the ideal air standard thermal efficiency based on the Otto cycle for a petrol engine with a cylinder bore of 50mm and stroke of 75 mm and a clearance volume of 21.3 cm^3.	(10)
		OR	
18	a)	1 kg of air at temperature of 15^0C and pressure of 100 kPa is taken through a Diesel cycle .The compression ratio is 15 and the heat added is 1850 KJ Calculate the ideal cycle efficiency?	(8)
	b)	Give the comparison between two stroke and four stroke engines.	(2)

Module-V

19	a)	With the help of a neat sketch explain the working of a simple unitary air conditioning system.	(6)
	b)	Define humidity ratio and relative humidity.	(4)
		OR	
20		Explain with a neat sketch, the working of a Pelton turbine	(10)
		Module-VI	
21	a)	Explain the general procedure used in making a sand mould for the casting	(4)
	b)	Describe the direct extrusion and indirect extrusion with sketches	(6)
		OR	
22		Discuss any four operations that can be performed on a lathe with simple sketches.	(10)

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ANSWERS:

12)

3.13. Fuel system for diesel engines

Fuel supply system for diesel engine consists of a fuel storage tank, filter, low pressure or transfer pump, high pressure fuel pump and fuel injector.

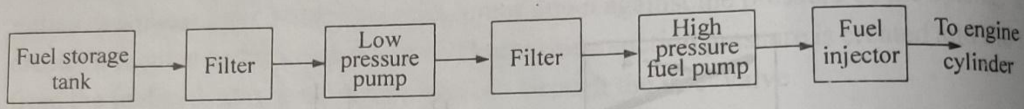


Fig. 3.12. Fuel supply system for diesel engine

The main parts of this system are fuel pump and fuel injector. The fuel is supplied at very high pressure from the fuel pump to the fuel injector and is injected to the engine cylinder towards the end of compression stroke. There are two types of injection systems . (i) Air injection (ii) Solid injection

Air injection

In this method, fuel is forced into the cylinder by means of compressed air. This method is obsolute these days as it requires multistage air compressor which increases the engine weight and cost. Moreover the compressor consumes about 10 % of the power developed by the engine and hence the output of the engine is reduced .

Solid injection (Mechanical injection)

In this method a fuel pump is used to supply measured quantity of fuel at high pressure to the injector. The injector injects the fuel at a very high velocity into the engine cylinder in the form of fine spray.

13)

through the delivery pipe.

Working principle

After priming, the impeller is rotated by means of an electric motor . Filling the suction pipe and casing with the liquid to be pumped is known as priming. Priming is required to remove air and vapour from the suction pipe and casing . The removal of air from the casing is required because the vaccum crated in the eye of the impeller is proportional to the density of the liquid that is in contact with the impeller. If the impeller is made to rotate in the presence of air, the vacuum created may not be sufficient to lift the water from the sump to the eye of the impeller. Therefore it is essential to prime a centrifugal pump before it can be started . The rotation of the impeller in the casing full of liquid produces a forced vortex

14)

→ Geardrive is called a positive drive since the force ~~req~~ required to hold the gears in position is much less than in equivalent friction drive. This results in ~~lower~~ lower bearing pressure, less wear on the bearing surface and ~~efficien~~ better efficiency.

→ Belt drive is not a positive drive since it is a friction drive and there is always some possibility of slipping between the belt and pulley.

15)

2. Requirement of skilled part programmer.

6.18 CAD/CAM

Computer-Aided Design (CAD) can be defined as any design activity that involves the effective use of the computer to create, modify, or document an engineering design. CAD involves creating computer models (2D drawings or 3D models of physical components) defined by geometrical parameters. These models typically appear on a computer monitor as a three-dimensional representation of a part or a system of parts, which can be readily altered by changing relevant parameters. CAD also used to have a conceptual design and layout of products, through strength and analysis of assemblies to define the manufacturing methods of components.CAD systems enable designers to view objects under a wide variety of representations and to test these objects by simulating real-world conditions.

Computer Aided Manufacturing (***CAM***) refers to an automation process, which accurately converts product design and drawing or the object into a code format, readable by the machine to manufacture the product. CAM systems are associated with ***Computer Numerical Control*** (CNC) systems. CAM complements the ***CAD*** systems to offer a wide range of applications in different manufacturing fields. A CAM system controls manufacturing operations performed by machine tools (such as milling machine, lathe, etc.) and other industrial tools. It moves the raw material to different machines within the system by allowing systematic completion of each step. Finished products can also be moved within the system to complete other manufacturing operations such as packaging. CAM can be applied to the fields of mechanical, electrical, industrial and aerospace engineering.

The term CAD/CAM system is used if it supports manufacturing as well as design applications. CAD and CAM are concerned principally with the engineering functions in design and manufacturing, respectively. Product design, engineering analysis, and documentation of the design (eg. drafting) represent engineering activities in the design function. Process planning, NC part programming, and many other activities associated with CAM represent engineering activities in manufacturing. In addition, CAM also includes other functions of manufacturing such as material requirements planning, production scheduling, computer production monitoring, and computer process control.

16)

Rapid Prototyping – Advantages

- Speed: part or product designed and tested in a short timeframe.
- Cost: most cost-effective among the forms of prototyping.
- Full-scale model can be prepared in minimum time
- Less waste: Because only the material that is needed is used, there is very little (if any) material wasted.

Rapid Manufacturing - Disadvantages

- Limited Material Selection
- Differences in Material Properties of different materials used in layers
- High Initial Investment and Required Maintenance Expertise
- Limited production scale.

17)

Problem : 2.5.

Calculate the ideal air standard thermal efficiency based on the Otto cycle for a petrol engine with a cylinder bore of 50 mm and stroke of 75 mm and a clearance volume of 21.3 cm^3.

Given: D = 50 mm = 5 cm $V_2 = 21.3\ cm^3$ L = 75 mm = 7.5 cm

To find:

η

$$V_1 = V_2 + \frac{\pi D^2}{4} \times L$$

$$= 21.3 + \frac{\pi \times 5^2}{4} \times 7.5 = 168.56\,cm^3$$

$$r = \frac{V_1}{V_2} = \frac{168.56}{21.3} = 7.91$$

$$\eta = 1 - \frac{1}{r^{\gamma-1}}$$

$$= 1 - \frac{1}{(7.91)^{1.4-1}} = 0.5628$$

$$\eta = 56.28\%$$

Problem : 2.6

18. a)

Problem : 2.11.

1 kg of air at temperature of 15°C and pressure of 100 kPa is taken through a Diesel cycle. The compression ratio is 15 and the heat added is 1850 kJ. Calculate the ideal cycle efficiency.

Solution:

Given: $m = 1\ kg \quad T_1 = 15^\circ C = 288\ K$

$p_1 = 100\ kPa\ Q\ added = 1850\ kJ, \quad r = 15$

To find: η

We have:

$$p_1V_1 = mRT_1$$

$$\therefore V_1 = \frac{mRT_1}{p_1} = \frac{1 \times 287 \times 288}{100 \times 10^3} = 0.827\,m^3$$

Given,

$$\frac{V_1}{V_2} = 15$$

$$\therefore V_2 = \frac{V_1}{15} = \frac{0.827}{15} = 0.055\,m^3$$

For the adiabatic process 1-2,

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

$$T_2 = T_1\left[\frac{V_1}{V_2}\right]^{\gamma-1}$$

$$= 288 \times (15)^{1.4-1} = 850.8\ K$$

For the constant pressure process 2-3,

$${}_2Q_3 = mC_p(T_3 - T_2)$$

$$1850 = 1 \times 1.005 \times (T_3 - 850.8)$$

$$T_3 = 2691.6\ K$$

$$\frac{V_2}{T_2} = \frac{V_3}{T_3}$$

$$V_3 = V_2 \times \frac{T_3}{T_2}$$

$$= 0.055 \times \frac{2691.6}{850.8} = 0.174\ m^3$$

$$\text{Cut off ratio } \rho = \frac{V_3}{V_2} = \frac{0.174}{0.055} = 3.16$$

Air standard efficiency,

$$= 1 - \frac{1}{\gamma(r)^{(\gamma-1)}}\left\{\frac{(\rho^\gamma - 1)}{(\rho - 1)}\right\}$$

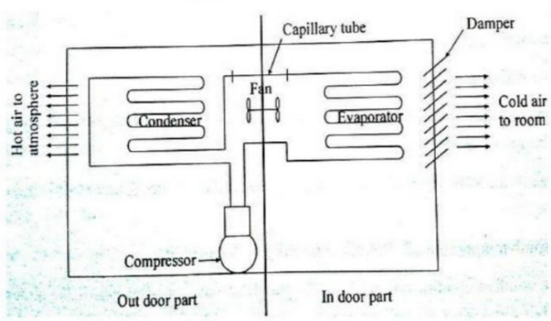
$$= 1 - \frac{1}{1.4(15)^{0.4}}\left\{\frac{(3.16^{1.4} - 1)}{(3.16 - 1)}\right\}$$

$$= 55.15\ \%$$

18.b)

TWO STROKE ENGINE	FOUR STROKE ENGINE
Cycle completed in 2 strokes or 1 revolution of crankshaft	Cycle completed in 4 strokes or 2 revolution of crankshaft
More power developed	Less power developed
Smaller flywheel	Heavier flywheel
Easier design	Complicated design
Ports are used	Valves are used
Easier to start	Not easier to start
Compression ratio is lower	Higher compression ratio
Less thermal efficiency	Higher thermal efficiency
Operating temperature is more	Less operating temperature
Less weight	Heavier engine
More noisy engine	Less noisy

19.a)



Unitary Air Conditioning System

Working: Low pressure vapour refrigerant from the evaporator is sucked by compressor and is compressed to a high pressure & is delivered to the condenser. In the condenser, the refrigerant vapour is condensed to liquid by releasing latent heat of condensation to the surrounding air. Hot air formed is driven out using a fan. High pressure liquid refrigerant enters the capillary tube where the pressure is reduced. This low pressure liquid-vapour refrigerant enters the evaporator. Liquid refrigerant evaporates by absorbing latent heat of vaporization from the surrounding air. This cold air is delivered to the room using a fan. Direction of air flow can be changed using a damper. Low pressure vapour refrigerant is again sucked by compressor. Thus one cycle of operation is completed.

19.b)

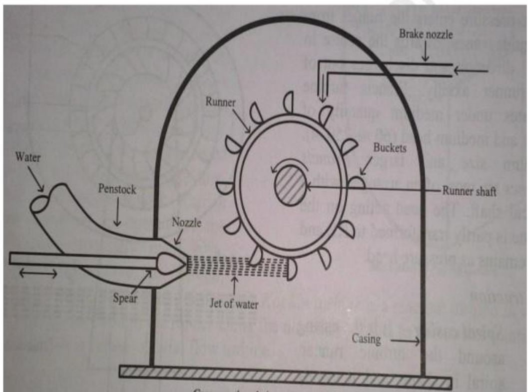
4. Specific or absolute humidity or humidity ratio: It is defined as the ratio of the mass of water vapour to the mass of dry air in a given volume of moist air. It is generally expressed as grams of water per kg of dry air.

5. Relative humidity: It is the ratio of mass of water vapour in a given volume of moist air at a given temperature to the mass of water vapour contained in the same volume of moist air at the same temperature when the air is saturated.

20)

Pelton Wheel

A Pelton wheel is an impulse-type water turbine invented by Lester Allan Pelton in the 1870s. **The Pelton wheel extracts energy from the impulse of moving water.** Nozzles direct forceful, high-speed streams of water against a series of spoon-shaped buckets, also known as impulse blades, which are mounted around the outer rim of a drive wheel - also called a runner.



Cross sectional view of Pelton turbine

Main Parts of a Pelton Turbine

- **Nozzle and flow regulating arrangement**
- **Runner and buckets:** Runner is a circular disc on the periphery of which a number of buckets are fixed.
- **Casing:** Prevent the splashing of water.
- **Breaking jet:** Used to stop the runner.

Working

Nozzle directs the water against buckets mounted around the runner. When the water jet strikes the bucket, the impulse energy of the water jet exerts torque (pressure) on the bucket-and-wheel system, spinning the wheel (runner). In the process, the water jet's momentum is transferred to the wheel and hence to a turbine. The runner shaft is connected with the generator, thus the electricity is produced.

21.a)

Moulding procedure

The general procedure used in making a sand mould for the casting shown in fig. 10.2 (a) is given below. The required pattern is shown in fig. 10.2 (b).

1. One half of the pattern is placed with its flat surface on a moulding board.

2. The drag is placed on the board with the pins downward.

3. The drag is filled with moulding sand and properly rammed.

4. Excess sand above the top level of drag is removed and levelled with the top of the drag. Fig. 10.2 (c).

5. The drag is turned over and placed on another board.

6. The other part of the pattern is kept over the first half and parting sand is prinkled over the surface . Now the cope is placed over the drag.

7. Runner and riser pins are placed at appropriate places and cope is filled with moulding sand , rammed properly.

8. Excess sand above the top level of cope is removed and levelled with the top of cope. Vent holes are made to ensure the escape of gases which are formed when molten metal is poured .

9. Runner and riser pins are removed (Fig. 10.2 d) and pouring basin is cut at the top of the sprue.

10. The cope is turned over and kept on a board

11. Pattern halves are carefully removed from the cope and drag.

12. Passage for the molten metal into the mould cavity known as gate is prepared on the top surface of the drag.

13. Repairs, if any, and cleaning of the mould cavity is carried out.

14. Surface of the mould cavity is sprinkled with fine graphite powder in order to get a good surface finish.

15. Core is kept in position.

16. The cope is kept back, carefully in position on the drag and clamped. The mould is now ready for pouring the molten metal. Fig. 10.2 (e).

17. After pouring the molten metal sufficient time is allowed for solidification. Once the solidification is over, the casting is taken out by breaking the mould. Fig. 10.2 (f).

18. The unwanted projections on the casting due to runner and riser are removed by cutting them off and the casting is cleaned.

21.b)

(d)

EXTRUSION PROCESS

Extrusion is a process ***used to create objects of a fixed cross-sectional profile***. ***A material is pushed through a die of the desired cross-section.*** The two main advantages of this process over other manufacturing processes are its ability to create very complex cross-sections, and to work materials that are brittle. It also forms parts with an excellent surface finish

- Process of forcing a metal enclosed in a container to flow through the opening of a die.
- Metal is subjected to plastic deformation
- Metal undergoes reduction and elongation during extrusion
- Used for manufacture rods, tubes, circular, rectangular, hexagonal and other shapes both in hollow and solid form.

Types of Extrusion

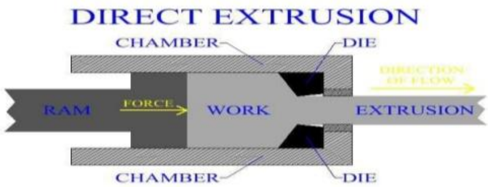
a) Direct Extrusion

b) Indirect Extrusion

c) Cold Extrusion/ Impact Extrusion

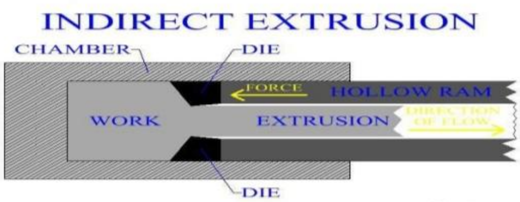
a) Direct Extrusion

Direct extrusion, also known as forward extrusion, is the most common extrusion process. It works by placing the billet in a heavy walled container. ***The billet (material) is pushed through the die by a ram or screw. Flow of metal through the die is in the same direction as the movement of ram.*** The major disadvantage of this process is that the force required to extrude the billet is greater than that needed in the indirect extrusion process.



b) Indirect Extrusion

- Also called backward extrusion
- Flow of metal through the die is in the opposite direction as the movement of ram
- Hot billet (work piece) is used
- Ram used is hollow
- Billet remains stationary while die is pushed into the billet by the hollow ram
- Less force is required as compared to direct extrusion



22)

Several operations like turning, taper turning, thread cutting, drilling, boring, grinding, etc. can be performed on a lathe. A brief description of some of the important operations that can be performed on a lathe are given below.

11.1.1 Turning

Turning is the removal of material from the periphery of a work piece to obtain a cylindrical surface. Turning can be carried out by holding the work in a chuck or by supporting the work in between lathe centres. The cutting tool, fed parallel to the axis of rotation of the work, removes material from the rotating work. The following procedure is adopted for turning.

i) Hold the workpiece in a chuck with a short length projecting out. Rotate it at a constant speed.

ii) Face the end of the work by feeding the tool perpendicular to the axis of rotation

iii) Drill a small hole at the centre of this faced surface. This can be done by fixing the drillbit in the tailstock and feeding it into the rotating workpiece.

iv) Remove the drillbit from the tailstock and fix the dead centre.

v) Set the workpiece between the chuck and the dead centre.

vi) Fix a tool in the tool post in such a way that the tip of the tool is in level with the axis of rotation of workpiece.

vii) Adjust the depth of cut by moving the tool perpendicular to the axis of work. After giving the depth of cut , the tool is moved parallel to the axis of the rotating work. For further reduction in diameter of the work, apply further depth of cut and traverse the tool again. For final finish the speed of rotation must be increased and a fine depth of cut must be given. The traversing of tool must also be slow and steady.

11.1.2 Taper turning

Some machine elements and other parts are required to be turned with a taper. Taper is expressed as the ratio of the difference in the end diameters to the length of tapered job, measured parallel to the axis. Taper turning means producing a conical surface by gradual reduction in diameter from a cylindrical workpiece. The following methods are used for taper turning.

(i) Forming tool method

Fig. 11.3. shows the method of taper turning by a forming tool. The tool having a straight cutting edge is set at correct angle and is fed straight into work to generate the tapered surface. This method is limited to turn short external tapers only.

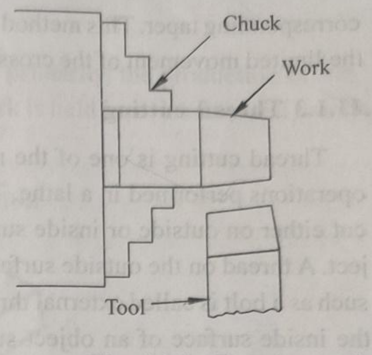


Fig. 11.3. Forming tool method

(ii) Tailstock set over method.

The principle of turning taper by this method is to shift the axis of rotation of the workpiece at an angle to the lathe axis and feeding the tool parallel to the lathe axis. The tool will cut a

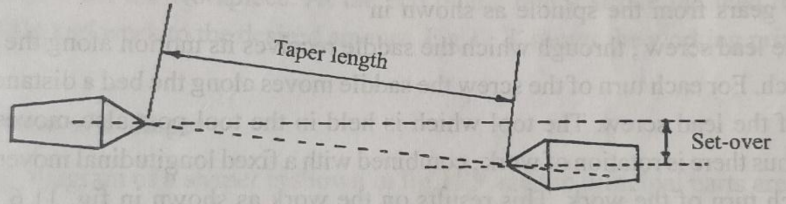


Fig. 11.4. Tail stock set over method.

taper on the work, the angle of which will be twice the inclination of the axes as shown in fig.11.4. This method is limited to the production of small taper on long jobs.

(iii) Compound rest method

The principle of turning taper by this method is to rotate the workpiece on the lathe axis and feeding the tool at an angle to the axis of rotation of the workpiece. The compound rest, on which the tool is mounted, has a circular base graduated in degrees. By swiveling compound rest, it can be set at any desired angle. For taper turning this angle must be half the taper angle. Once the compound rest is set at the desired angle, rotation of the compound slide screw will cause the tool to be fed at that angle and generate a

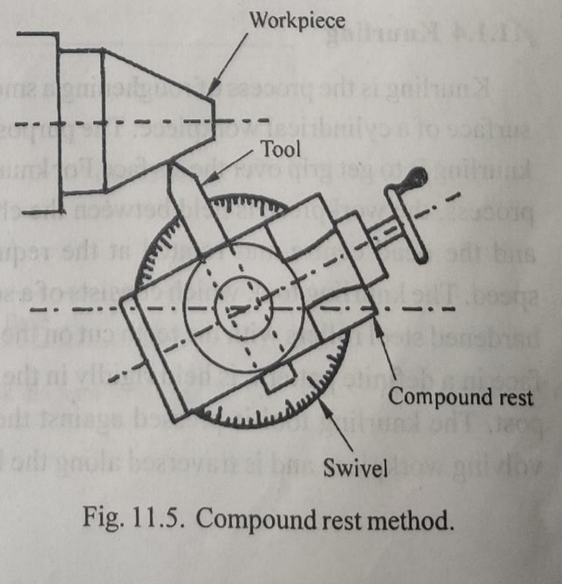


Fig. 11.5. Compound rest method.

corresponding taper. This method shown in fig. 11.5. is limited to turn a short taper owing to the limited movement of the cross slide.

11.1.3 Thread cutting

Thread cutting is one of the most important operations performed in a lathe. Threads can be cut either on outside or inside surface of an object. A thread on the outside surface of an object such as a bolt is called external thread. Thread on the inside surface of an object such as a nut is called internal thread.

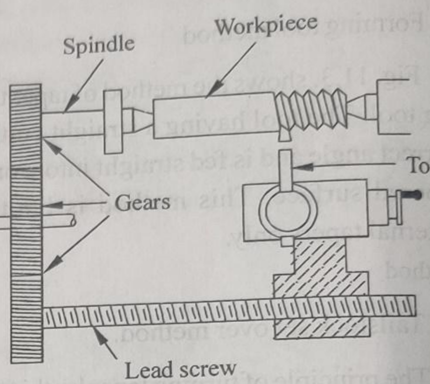


Fig. 11.6. Thread cutting.

For cutting a thread, it is necessary that there should be a relation between the movement of the tool and rotation of work. This is obtained by means of a lead screw. The lead screw is driven by a set of gears from the spindle as shown in fig.11.6 The lead screw , through which the saddle receives its motion along the bed, has a definite pitch. For each turn of the screw the saddle moves along the bed a distance equal to the pitch of the lead screw. The tool which is held in the tool post also moves the same distance. Thus there is rotation of work , combined with a fixed longitudinal movement of the tool for each turn of the work. This results on the work as shown in fig. 11.6. The gears connecting the headstock spindle with the lead screw can be selected to cut a thread of any desired pitch. For example, suppose the pitch of a lead screw is 12 mm and it is required to cut a screw of 4 mm pitch, then the gears are to be so selected that the spindle rotates 3 times the speed of the lead screw.

11.1.4 Knurling

Knurling is the process of roughening a smooth surface of a cylindrical workpiece. The purpose of knurling is to get grip over the surface.For knurling process, the workpiece is held between the chuck and the dead centre and rotated at the required speed. The knurling tool, which consists of a set of hardened steel rollers with the teeth cut on the surface in a definite pattern, is held rigidly in the tool post. The knurling tool is pressed against the revolving workpiece and is traversed along the length to be knurled as shown in fig.11.7

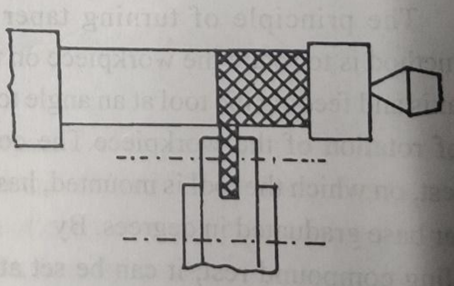


Fig. 11.7 Knurling