



**NATIONAL
SENIOR CERTIFICATE**

GRADE 11

NOVEMBER 2022

**MECHANICAL TECHNOLOGY: FITTING AND
MACHINING
(EXEMPLAR)**

MARKS: 200

TIME: 3 hours

This question paper consists of 18 pages, including a formula sheet.

INSTRUCTIONS AND INFORMATION

1. Write your NAME on the ANSWER BOOK.
2. Read ALL the questions carefully.
3. Answer ALL the questions.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Start EACH question on a NEW page.
6. Show ALL calculations and units. Round off final answers to TWO decimal places.
7. You may use a non-programmable scientific calculator and drawing instruments.
8. The value of gravitational force should be taken as 10 m.s^{-2} .
9. All dimensions are in millimeters, unless stated otherwise in the question.
10. A formula sheet is attached to the question paper.
11. Write neatly and legibly.
12. Use the criteria below to assist you in managing your time.

QUESTION	CONTENT	MARKS	TIME
GENERIC			
1	Multiple-choice questions	20	15 minutes
2	Safety	24	15 minutes
3	Tools and Equipment	16	10 minutes
4	Maintenance	8	10 minutes
5	Materials	32	25 minutes
SPECIFIC			
6	Terminology	25	30 minutes
7	Tools and Equipment	8	8 minutes
8	Forces	19	19 minutes
9	Maintenance	8	8 minutes
10	Joining Methods	12	12 minutes
11	Systems and Control	16	16 minutes
12	Pumps	12	12 minutes
TOTAL:		200	180 minutes

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC) (COMPULSORY)

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A–D) next to the question numbers (1.1 to 1.20) in your ANSWER BOOK, for example 1.21 A.

- 1.1 Which of the following options is correct in terms of the occupational health and safety act (OHS act No. 85 of 1993) as one of the national policies and procedures dealing with HIV/Aids?
- A The act emphasises the working relations of employees and employers
 - B Elaborates how everybody has the right to fair labour practice
 - C It states that all employers must make sure that the workplace is safe and that the employees are not at risk of becoming infected with HIV at work
 - D It contains common guidelines on how employers, employees and trade unions should respond to HIV/Aids in the workplace (1)
- 1.2 Which of the following is an example of unsafe condition?
- A Insufficient ventilation in the workshop
 - B Adjusting or lubricating a machine that is in motion
 - C Using machine without having required training
 - D Using hands or feet instead of available equipment. (1)
- 1.3 In order for a workshop to run successfully, it is important for the workers to report the daily operations of the workshop which include ...
- A maintenance and requirements of machines or equipments to prevent production flow interruption.
 - B work progress.
 - C accident and causes.
 - D All of the above. (1)
- 1.4 Which ONE of the following safety procedures is applicable to the operation of a guillotine?
- A Make sure the space between the tool rest and emery disc does not exceed 3 mm
 - B Do not attempt to cut material beyond the capacity of the machine
 - C Select the correct drill bit
 - D Use the machine table as an anvil. (1)

- 1.5 What safety measure is applicable to the use of the tool in FIGURE 1.5 below in terms of the Occupational Health and Safety Act?



FIGURE 1.5

- A Check the pressure gauge regularly for adjustment or replacement before work commences
- B Remove guards before grinding.
- C Make sure that there are no cracks on the disc before you start a job
- D It can be forced to grind thick material (1)
- 1.6 Which of the following safety precautions must be carried out on a small workpiece before drilling operation can be done on a pedestal drilling machine?
- A Clean the workpiece properly with a dry cloth
- B Hold the workpiece firmly by hand
- C Clamp the workpiece securely on the work table
- D All of the above. (1)
- 1.7 What is the colour code for acetylene cylinder?
- A Maroon
- B Red
- C Blue
- D Black (1)
- 1.8 Why is it important to use cutting fluid when cutting a hardened medium carbon steel with a power saw?
- A In order to soften the steel
- B In order to prolong the lifespan of the cutting tool as it cuts through the hardened steel
- C In order to have a straight cut
- D In order to change the texture of the chips (1)
- 1.9 What will be the tap drill size for an M12 x 2.5?
- A 12,50 mm
- B 12,00 mm
- C 14,50 mm
- D 9,50 mm (1)

- 1.10 Which ONE of the following tools is used to enlarge pop marks on a work piece before drilling commences?
- A Centre punch
 - B Scriber
 - C Vernier caliper
 - D Steel rule
- (1)
- 1.11 What is the function of the depth gauge on the drill press?
- A Prevent damages to the cutting tool
 - B Guides the cutting into the hole
 - C Indicates the depth of the hole
 - D Pop marks on the workpiece before drilling
- (1)
- 1.12 What is the function of the screen of a pedestal grinder?
- A Lubricates the grinding process
 - B Serves as a wheel dresser
 - C Aligns the grinding disc in order to prevent vibrations
 - D Protects the eyes from sparks and abrasive materials expelled from the grinding disc
- (1)
- 1.13 Which of the following is the cause of malfunction of a pedestal drilling machine?
- A Lack of lubrication or incorrect lubrication
 - B Friction
 - C Overload
 - D All of the above.
- (1)
- 1.14 Why do we carry out wheel dressing as part of the maintenance procedure in pedestal grinding machines?
- A To remove the dull outer layer of the wheel grinding surface in order to expose the sharp grains
 - B To align the wheel properly on the spindle
 - C To check if there are cracks on the grinding wheel
 - D To fix the cracks on the grinding wheel
- (1)
- 1.15 When iron ore is smelted in blast furnace, what form of iron is produces in the process?
- A Steel
 - B Chromed steel
 - C Pig iron
 - D Cast iron
- (1)

- 1.16 Which of the following furnace is used in the production of stainless steel?
- A Blast furnace
 - B Electric furnace
 - C Rotor plant
 - D Bessemer converter furnace
- (1)
- 1.17 The electrodes of an electric furnace is made of ...
- A steel.
 - B carbon.
 - C copper.
 - D cast iron.
- (1)
- 1.18 Which of the following properties of material allows a material to return to its original shape when a tensile load is removed?
- A Elasticity
 - B Brittleness
 - C Plasticity
 - D Malleability
- (1)
- 1.19 What is the function of the hand tools shown in FIGURE 1.19 below?



FIGURE 1.19

- A Countersink a workpiece
 - B Open and locking bolts and nut
 - C Cut internal and external thread
 - D Drill a hole
- (1)
- 1.20 What is the unit of torque?
- A Cm^3
 - B N/m^2
 - C N/m
 - D Nm

(1)
[20]

QUESTION 2: SAFETY (GENERIC)

- 2.1 What do you understand by the term *accident* in the workshop? (2)
- 2.2 List any THREE unsafe acts you know of in the workshop. (3)
- 2.3 Give THREE safety rules that must be adhered to in order to prevent an accident from taking place in the workshop. (3)
- 2.4 Give THREE safety measures that must be in place before welding of flame cutting can be undertaken. (3)
- 2.5 When handling oxi-acetylene gas welding cylinders, state THREE safety precautions you must take into consideration. (3)
- 2.6 Why is it very important to install flashback arrestors as a safety precaution on the hose pipes of a oxi-acetylene gas welding system? (2)
- 2.7 Give THREE safety precautions that must be observed when using a hydraulic press (3)
- 2.8 Why is it important to wear goggles when grinding a workpiece on a pedestal grinder? (1)
- 2.9 Which safety precaution must be observed at the completion of work operations on machine tools in the workshop? (1)
- 2.10 State THREE safety precautions you must take into consideration before operating a power saw. (3)

[24]

QUESTION 3: TOOLS (GENERIC)

3.1 FIGURE 3.1 below is a common tool used in thread cutting



FIGURE 3.1

3.1.1 Identify the tool in FIGURE 3.1 above. (1)

3.1.2 What is the function of the tool in FIGURE 3.1 above? (2)

3.2 List the THREE types of taps commonly used in the workshop. (3)

3.3 Study the diagram in FIGURE 3.3 below and answer the questions that follow.

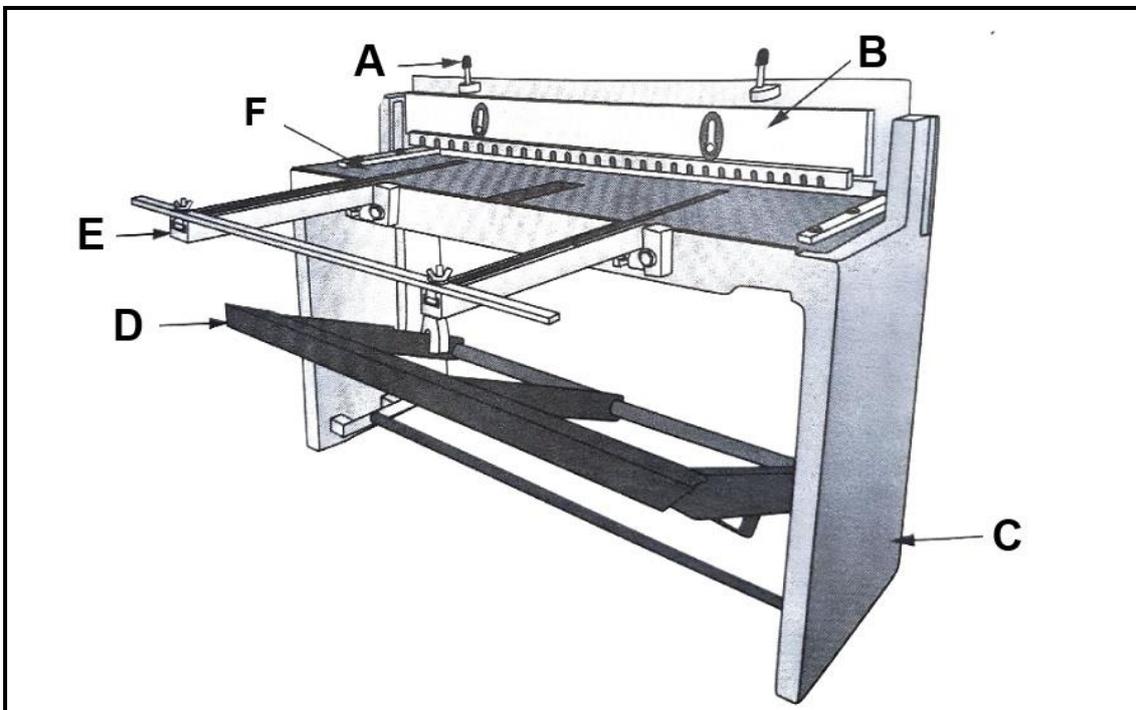


FIGURE 3.3

3.3.1 Identify the diagram in FIGURE 3.3 above. (1)

3.3.2 What is the tool in FIGURE 3.3 used for in the workshop? (2)

3.3.3 Label parts **A–F** in FIGURE 3.3 above. (6)

3.3.4 What is the maximum thickness of materials the tool in FIGURE 3.3 above can accommodate? (1)

[16]

QUESTION 4: MAINTENANCE (GENERIC)

- 4.1 List TWO factors that needs to be taken into account when selecting a drill speed on a pedestal drilling machine. (2)
 - 4.2 A 12 mm hole must be drilled into a piece of metal. The cutting speed given is 500 mm per second. Calculate the required drill speed of the drill in revolutions per minute. (4)
 - 4.3 What will be the effect of excessive friction when drilling a hole on a pedestal drilling machine? (1)
 - 4.4 How can you reduce the effect of excessive friction during the course of drilling a hole on a pedestal drill? (1)
- [8]

QUESTION 5: MATERIALS (GENERIC)

- 5.1 The diagram in FIGURE 5.1 below is one of the furnace used in metallurgical industries. Use it to answer the following questions.

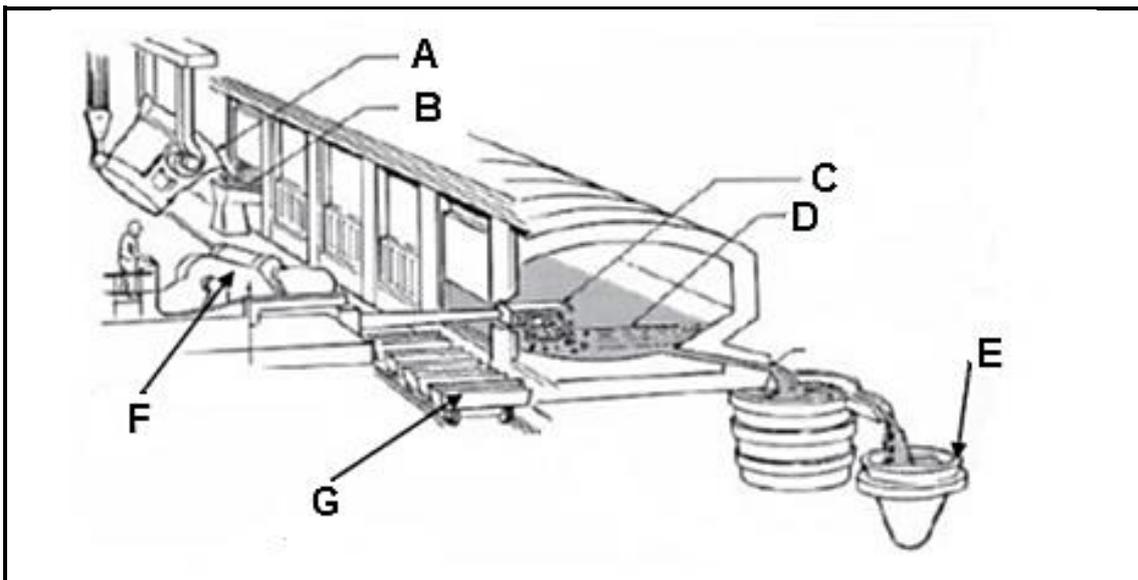


FIGURE 5.1

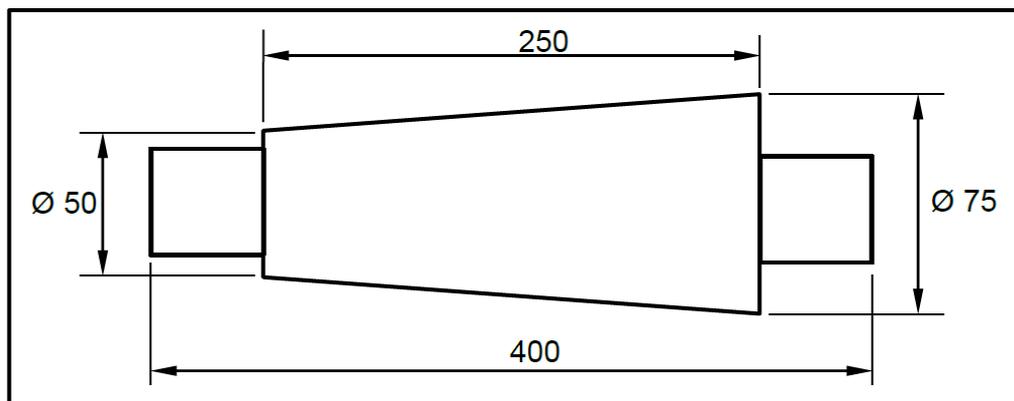
- 5.1.1 Identify the type of furnace in the FIGURE 5.1 above. (1)
 - 5.1.2 Label parts **A–G** in the FIGURE 5.1 above. (7)
 - 5.1.3 What is the function of the furnace in the FIGURE 5.1 above? (2)
- 5.2 The flow chart below show the process through which iron ore is transformed to steel. Identify the different furnaces (**A** and **B**) in each stage of the transformations.



- 5.3 Explain the following properties of the materials shown below:
- 5.3.1 Elasticity (2)
 - 5.3.2 Flexibility (2)
 - 5.3.3 Malleability (2)
 - 5.3.4 Hardness (2)
- 5.4 Give TWO advantages of the rotating action of the refractory brick lining in a Rotor plant. (2)
- 5.5 In a Rotor plant, the melting process takes place in the atmosphere which within limit, may be controlled. Give THREE advantages of this process. (3)
- 5.6 Coke is a very important material used during the charging of blast furnace. Give THREE important roles that coke plays in this process. (3)
- 5.7 What is the function of the following furnaces in metallurgical industries?
- 5.7.1 Blast furnace (2)
 - 5.7.2 Electric furnace (2)
- [32]**

QUESTION 6: TERMINOLOGY (SPECIFIC)

- 6.1 A parallel key must be machined to fit onto a 144 mm diameter shaft. Calculate the following:
- 6.1.1 The width of the key (2)
- 6.1.2 The thickness of the key (2)
- 6.1.3 The length of the key (2)
- 6.2 You must cut a taper on your work piece using the compound slide method. The dimensions of the taper are shown on FIGURE 6.2:

**FIGURE 6.2**

- Calculate the angle to which the compound slide must be set at to cut this taper. (5)
- 6.3 Calculate the pitch of a two-start square thread if the lead is 14 mm. (2)
- 6.4 List any FOUR turning operations that can be executed on a centre lathe. (4)
- 6.5 Explain the *taper-turning procedure* using the compound-slide method. (4)
- 6.6 Describe the difference between a horizontal and a vertical milling machine. (4)

[25]

QUESTION 7: TOOLS AND EQUIPMENT (SPECIFIC)

7.1 Tools and equipment are very important to complete different tasks in the workplace. Explain the function of EACH of the following equipment:

7.1.1 Dial indicator (2)

7.1.2 Torque wrench (2)

7.2 FIGURE 7.2 below shows a vernier calliper reading.

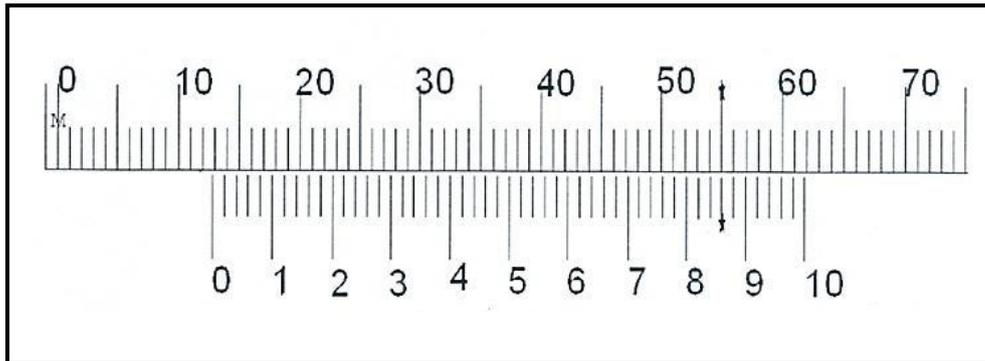


FIGURE 7.2

7.2.1 Study the reading on the vernier calliper and record it on your ANSWER SHEET. (2)

7.3 Make a sketch of the micrometer reading showing 17,42 mm. (2)
[8]

QUESTION 8: FORCES (SPECIFIC)

8.1 Explain the following terms.

8.1.1 Moment of force (1)

8.1.2 Stress (1)

8.1.3 Component of force (1)

8.2 Study the beam below and answer the questions that follow.

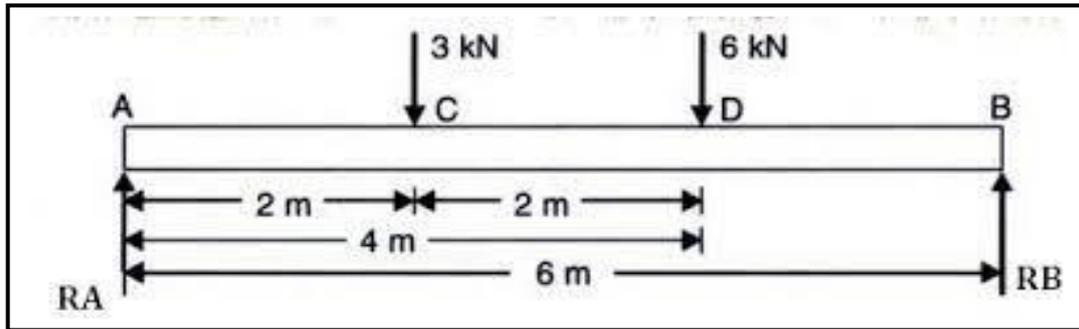
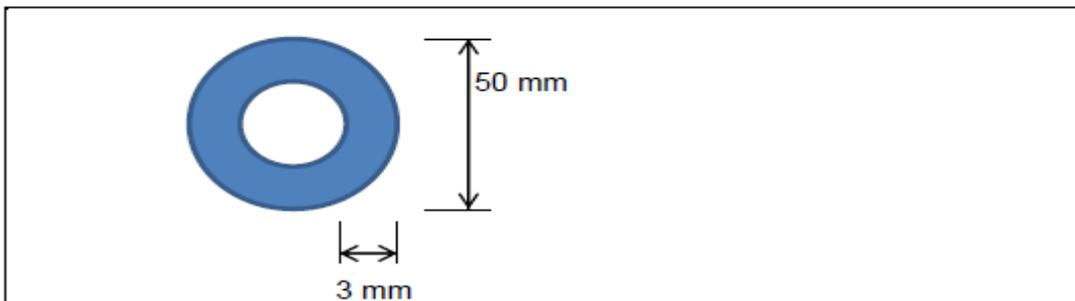


FIGURE 8.2

Calculate the magnitude of the reactions in supports. (4)

8.3 Calculate the compressive stress in a 50 x 3 mm round tube if it is subjected to a load of 70 kN.



(6)

8.4 FIGURE 8.4 below shows a system of forces with three forces acting on the same point.

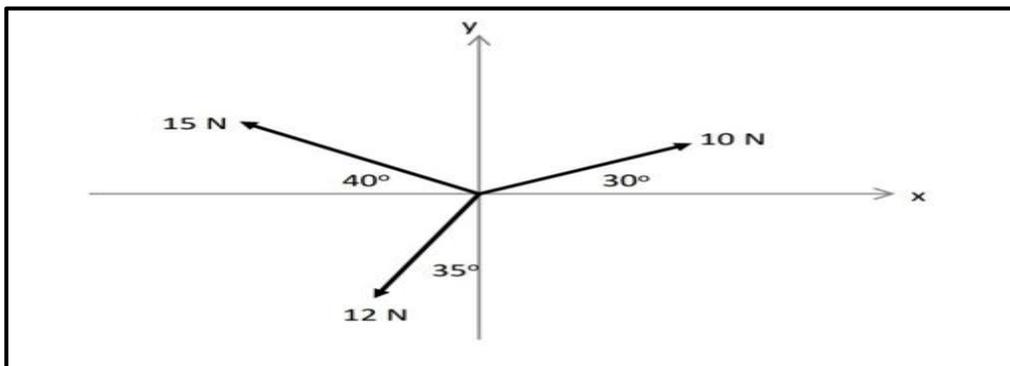


FIGURE 8.4

8.4.1 Use calculations and determine the **magnitude** and **direction of the resultant** force of this system of forces.

(6)
[19]

QUESTION 9: MAINTENANCE (SPECIFIC)

9.1 Explain the meaning of the following terms:

9.1.1 Dynamic balancing (2)

9.1.2 Static balancing (2)

9.2 Give TWO effects that cause malfunction of operating systems due to friction and the lack of maintenance. (2)

9.3 Define the term *coefficient of friction*. (2)

[8]

QUESTION 10: JOINING METHODS (SPECIFIC)

10.1 Screw threads are fundamental to industrial progress, FIGURE 10.1 is an external metric screw thread which can be manufactured by cutting on a lathe.

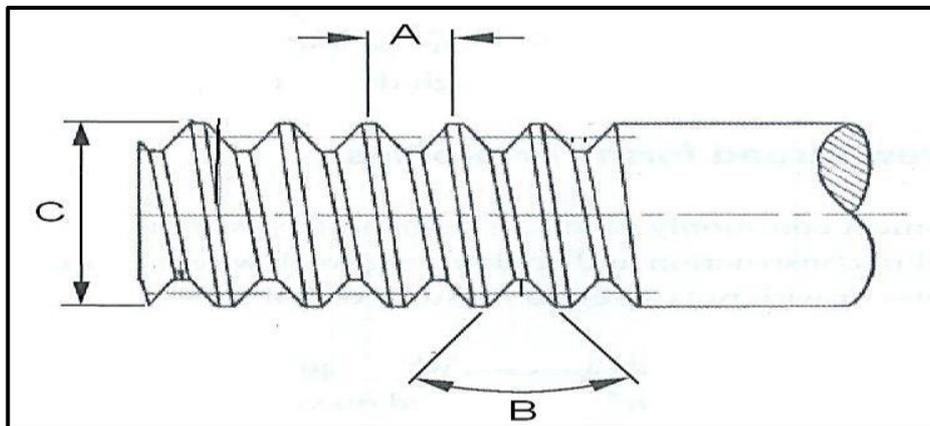


FIGURE 10.1

10.1. IDENTIFY the labels (**A**, **B** and **C**) on the screw thread shown in
1 FIGURE 10.1 and write down the DEFINITION for each label.

(3 + 3) (6)

10.2 A 6-mm pitch, three-start screw thread is to be cut on a centre lathe.
Calculate the lead of the screw thread. (3)

10.3 Define the *axis* of a screw thread. (1)

10.4 List TWO basic applications of screw threads. (2)

[12]

QUESTION 11: SYSTEMS AND CONTROL (SPECIFIC)

- 11.1 List TWO advantages of chain drives. (2)
- 11.2 A hydraulic system is used to lift a machine. A force of 300N is exerted on the 50 mm diameter plunger of a hydraulic jack. The diameter of the ram is 500 mm as shown in FIGURE 11.2 below.

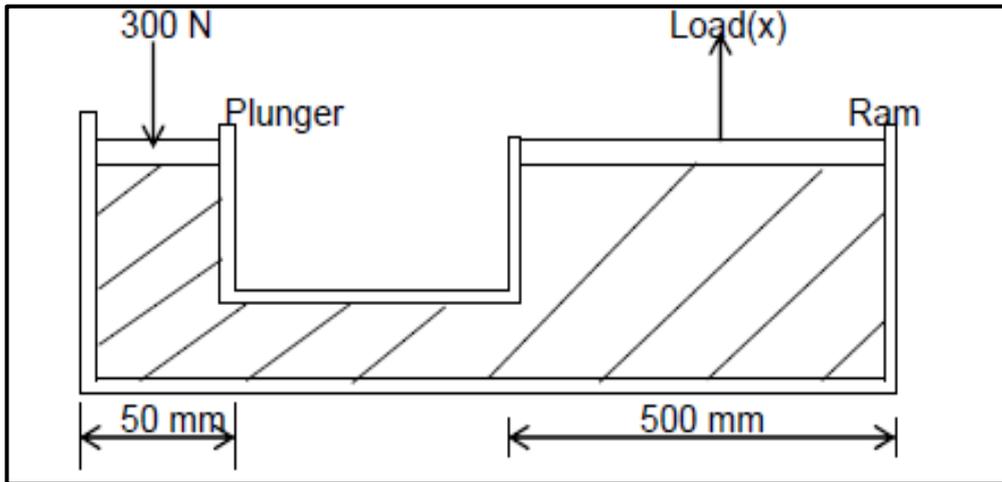


FIGURE 11.2

Calculate:

- 11.2.1 Fluid pressure in the hydraulic system when in equilibrium (4)
- 11.2.2 Load (Force) on ram that can be lifted by the hydraulic jack (4)
- 11.3 FIGURE 11.3 below indicates gears meshing with one another.

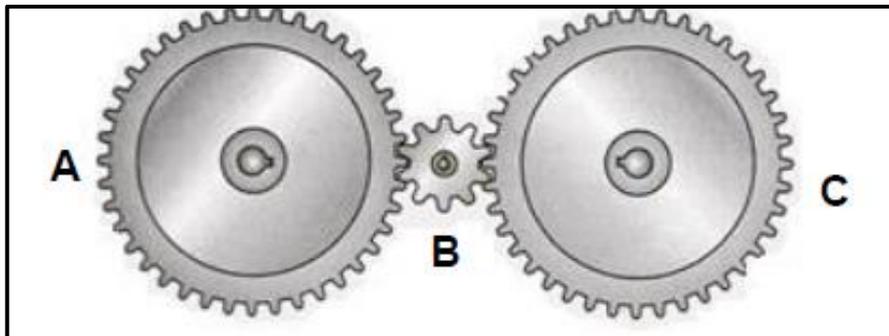


FIGURE 11.3

Calculate the following:

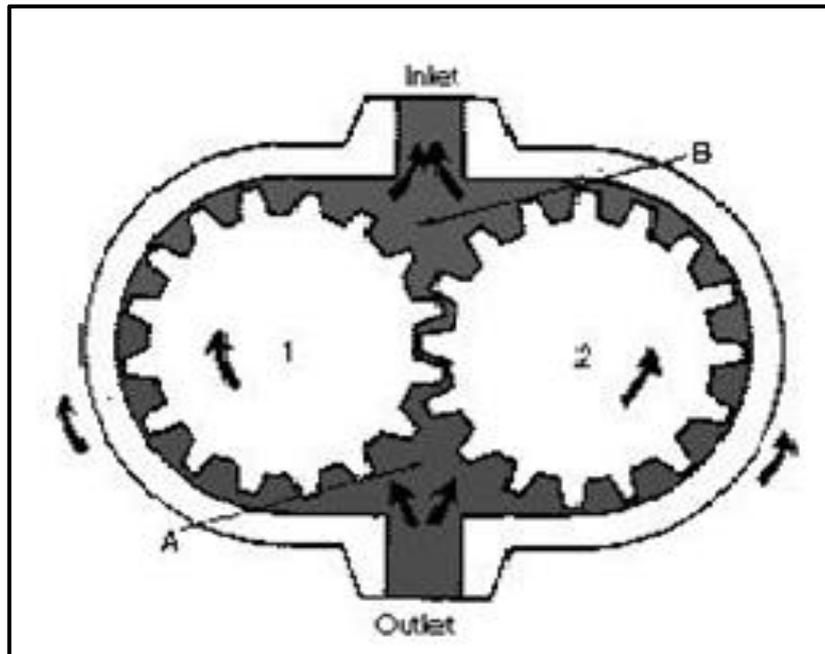
- 11.3.1 If gear C is turning clockwise, in which direction will gear A turn? (1)
- 11.3.2 What is an *idler gear*? (2)
- 11.4 A shaft revolving at 900 rpm has a 380 mm diameter pulley which drives a 150 mm diameter pulley on a second shaft by means of a driving belt.

Calculate the speed of the driven shaft in rpm (Simple Belt drive) (3)

[16]

QUESTION 12: PUMPS (SPECIFIC)

- 12.1 Write down ONE advantage a centrifugal pump provides above that of a reciprocating pump. (1)
- 12.2 What are the TWO main differences between a piston pump and plunger pump? (2)
- 12.3 FIGURE 12.3 shows a type of pump which can be used.

**FIGURE 12.3**

- 12.3.1 Identify the type of pump shown in FIGURE 12.3. (1)
- 12.3.2 Explain the operation of the pump in FIGURE 12.3. (4)
- 12.4 Briefly describe the function of the following types of impellers:
- 12.4.1 Open impeller (2)
- 12.4.2 Enclosed impeller (2)

[12]**TOTAL: 200**

4. GEAR DRIVES

$$4.1 \quad N_1 T_1 = N_2 T_2$$

where N = rotational frequency
T = number of teeth on the gear

$$4.2 \quad \text{Power (P)} = \frac{2\pi TN}{60}$$

$$4.3 \quad \text{Gear ration} = \frac{\text{Product of the number of teeth of driver gears}}{\text{Product of the number of teeth of driven gears}}$$

$$4.4 \quad \frac{N_{\text{input}}}{N_{\text{output}}} = \frac{\text{Product of the number of teeth of driven gears}}{\text{Product of the number of teeth of driving gears}}$$

5. POWER

$$IP = \rho LANn$$

6. SCREW THREAD

$$6.1 \quad \text{Lead} = \text{number of starts} \times \text{pitch}$$

$$6.2 \quad \text{Helix angle: } \tan \theta = \frac{\text{lead}}{\pi \text{ diameter}}$$

$$6.3 \quad \text{Leading tool angle} = 90^\circ - (\text{clearance angle} + \text{helix angle})$$

$$6.4 \quad \text{Following tool angle} = 90^\circ + (\text{helix angle} - \text{clearance angle})$$

$$6.5 \quad \text{Depth of thread : } H = 0,866 P$$

$$6.6 \quad \text{Pitch diameter of thread : } = OD - \left[\frac{3 \times H}{8} \right]$$

7. TAPER TURNING

$$\text{Compound slide angle } \frac{\theta}{2} = \frac{D - d}{2t}$$

8. HYDRAULICS

$$8.1 \quad A_{\text{piston}} = \frac{\pi d^2}{4}$$

$$8.2 \quad \text{Pressure} = \frac{\text{Force}}{\text{Area}} \quad \text{OR} \quad p = \frac{F}{A}$$