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JUNE EXAMINATION GRADE 12

2026

NAME:	
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SCHOOL:	
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SUBJECT:	MECHANICAL TECHNOLOGY: FITTING AND MACHINING
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ANSWER ALL THE QUESTIONS IN THE QUESTION PAPER.

MARKER					INT. MODERATOR				DIST. MODERATOR				PROV. MODERATOR			
Question	Marks			Marker's code & initials	Marks			IM's code & initials	Marks			DM's code & initials	Marks			PM's code & initials
1																
2																
3																
4																
5																
6																
7																
8																
TOTAL																

TIME: 3 hours

MARKS: 200

33 pages + a 5-page formula sheet



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INSTRUCTIONS AND INFORMATION

1. This question paper consists of EIGHT questions. Answer ALL the questions in the spaces provided.
2. Use the mark allocation as a guide to the length of your answer.
3. Show ALL calculations and units. Round-off final answers correctly to TWO decimal places.
4. You may use non-programmable scientific calculators and drawing instruments.
5. The value of gravitational acceleration should be taken as $9,81 \text{ m/s}^2$ or 10 m/s^2 .
6. All dimensions are in millimetres, unless stated otherwise in the questions.
7. A FORMULA SHEET is attached at the end of the question paper.
8. Drawings in the question paper are NOT to scale due to electronic transfer.
9. No pages may be torn from this question paper.
10. Candidates may not retain a question paper or remove it from the examination room. Question papers must be returned to the invigilator at the end of the examination session.
11. Answers must be written in black/blue ink as distinctly as possible. Do NOT write in the margins.
12. Indicate the questions you have answered by drawing a circle around the relevant numbers on the front cover of the question paper where marks are to be recorded.
13. Draw a neat line through any work/rough work that must NOT be marked.
14. Write neatly and legibly.
15. Use the criteria below to assist you with your time management.

QUESTION	CONTENT	MARKS	TIME IN MINUTES
GENERIC			
1	Multiple-choice Questions	6	6
2	Safety	18	18
SPECIFIC			
3	Multiple-choice Questions	14	10
4	Terminology (Lathe and Milling machine)	32	27
5	Terminology (Indexing)	33	29
6	Tools and Equipment	26	24
7	Forces	45	42
8	Maintenance	26	24
TOTAL		200	180


QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A – D) for each of the corresponding questions (1.1 to 1.6) in the blocks provided.

- 1.1 Which of the following statements is CORRECT for a bench grinder? (1)
- A Oil the grinding disk before starting the machine.
B Stand to the side of the machine when switching it on.
C Grind only on the side of the grinding disk.
D PPE is optional when working on a bench grinder.
- 1.2 Which of the following statements best describes the function of the pressure gauge in a hydraulic press? (1)
- A Clamp the jig securely.
B Secure the supporting pins.
C Observe the working pressure.
D Ensure that the frame is perpendicular to the base.
- 1.3 Which of the following statements is CORRECT when referring to a process layout? (1)
- A A process layout is ideal for mass production.
B The packaging of the material inflates the costs.
C The machines are arranged according to the order of operations.
D Each stage of production is performed in a separate department.
- 1.4 The function of the rear-light curtain on a power-driven guillotine is to prevent (1)
- A gaining access to the two-button control unit.
B being pinched by the ram.
C reaching the blades.
D getting their fingers pinched by the hold-downs.
- 1.5 Which of the following represents visible signs and symptoms observed prior to rendering first aid? (1)
- A Wet or slippery floors
B Fragments of glass
C Heart rate
D Bleeding from any part of the body
- 1.6 What is the allowable maximum thickness of metal plates for cutting on a manual guillotine? (1)
- A 4,4 mm
B 2,0 mm
C 1,2 mm
D 1,0 mm




QUESTION 2: SAFETY (GENERIC)

2.1	Name TWO safety precautions for EACH of the following machines used in a mechanical workshop. (NOTE: ALL loose hair, clothing, jewelry and PPE have already been addressed.)	
-----	--	--

2.1.1	Lathe	
		(2)

2.1.2	Pedestal drill	
		(2)

2.1.3	Horizontal band saw	
		(2)

2.2	Name TWO advantages of the following:	
-----	---------------------------------------	--

2.2.1	Product layout	
		(2)



2.2.2	Process layout	
		(2)

2.3 FIGURE 2.3 below shows a machine used in a mechanical workshop. Answer the questions that follow.

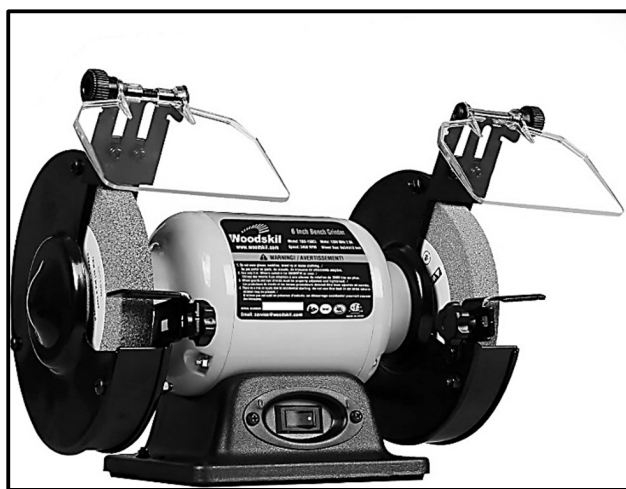


FIGURE 2.3

2.3.1	Identify the machine shown in FIGURE 2.3.	
		(1)

2.3.2	Name FOUR safety messages that must be displayed on safety signs around this machine.	
		(4)



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2.4	Give TWO reasons why a two-hand control device would be used on a power-driven guillotine in a mechanical workshop.	
		(2)

2.5	State the second stage when performing first aid.	
		(1)

[18]

QUESTION 3: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A – D) for each of the corresponding questions (3.1 to 3.14) in the blocks provided.

3.1 Machining work that is out of balance results in ...

- A a good finish.
- B a round workpiece.
- C more speed.
- D clatter on the gear teeth.

(1)

3.2 What type of milling process is shown in FIGURE 3.2?

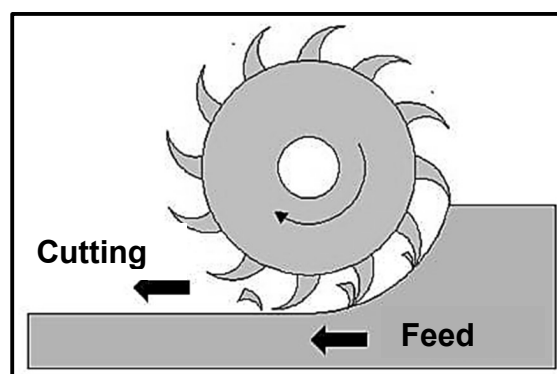


FIGURE 3.2

- A Up-cut milling
- B Gang milling
- C Straddle milling
- D Down-cut milling

(1)



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- 3.3 What does the third axis represent on a Digital Readout (DRO) system?
- A X-axis
B Z-axis
C H-axis
D A-axis (1)
- 3.4 If the lead screw is rotating but the dial gauge is not turning, what is the most likely cause of this condition?
- A Incorrect thread angle
B Half-nuts engaged
C The dial gear not contacting the lead screw
D Excessive lubricant on the lead screw (1)
- 3.5 Which gauge is used to verify that a cutting tool is correctly shaped for cutting a screw thread?
- A Thread pitch gauge
B Screw cutting dial gauge
C Indicator gauge
D Centre gauge (1)
- 3.6 When cutting tapers, the compound slide can be at ... of the included angle.
- A the whole
B three-quarters
C half
D a quarter (1)



3.7 Identify the type of hardness tester shown in FIGURE 3.7 below.

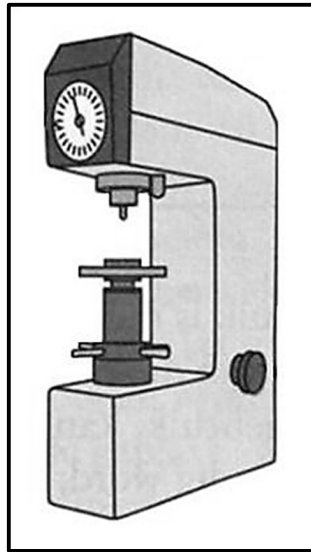


FIGURE 3.7

- A Tensile hardness tester
- B Torque hardness tester
- C Rockwell hardness tester
- D Pascal hardness tester

(1)

3.8 What type of material is used to make the Brinell hardness tester indenter?

- A Copper
- B Carbide
- C Aluminium
- D Stone

(1)

3.9 Which of the following governs the value of the safety factor?

- A The value of the minimum load
- B The consequences of success
- C The unreliability of the material
- D The effect of corrosion and wear

(1)



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3.10 What is the unit for *strain*?

- A Pascal
- B No unit
- C Millimetre
- D Metres

(1)

3.11 What type of stress is caused in a cable of a hoisting crane when lifting a load?

- A Tensile stress
- B Form stress
- C Shearing stress
- D Compressive stress

(1)

3.12 What does the term *stress* mean?

- A It is the inherent opposition of a body to an applied force.
- B It shows how unwilling a body is to change its state of motion.
- C It is the amount by which a material stretches or compresses when a force is applied.
- D It refers to a force applied from outside onto a substance.

(1)

3.13 Which of the following materials can be used to manufacture bushes in the mechanical workshop?

- A Wood
- B Fibreglass
- C Vesconite
- D Glass

(1)

3.14 From which two natural materials is PVC created?

- A Cement and stone
- B Sand and oil
- C Water and coal
- D Wood and oil

(1)

[14]



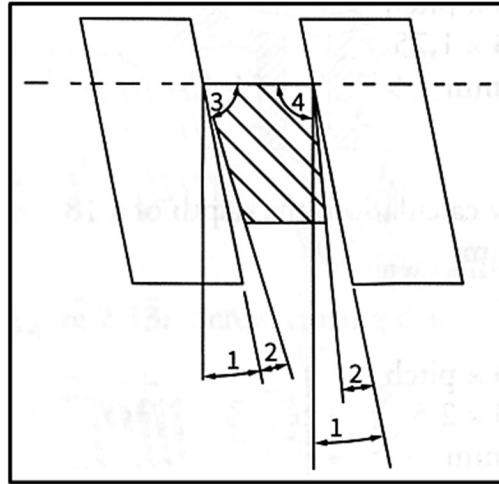
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QUESTION 4: TERMINOLOGY (LATHE AND MILLING MACHINE) (SPECIFIC)

4.1

Label the cutting tool angles (1 – 4) for the cutting of square threads in FIGURE 4.1.

**FIGURE 4.1**

1:

2:

3:

4:

(4)

4.2

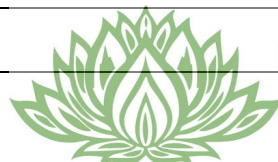
Explain the operation of the screw-cutting dial gauge.

(2)

4.3

Name TWO disadvantages of the tailstock set-over method.

(2)

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4.4	Name TWO advantages of the compound slide method.	
		(2)

4.5 FIGURE 4.5 below shows a taper with an included angle of 10° .

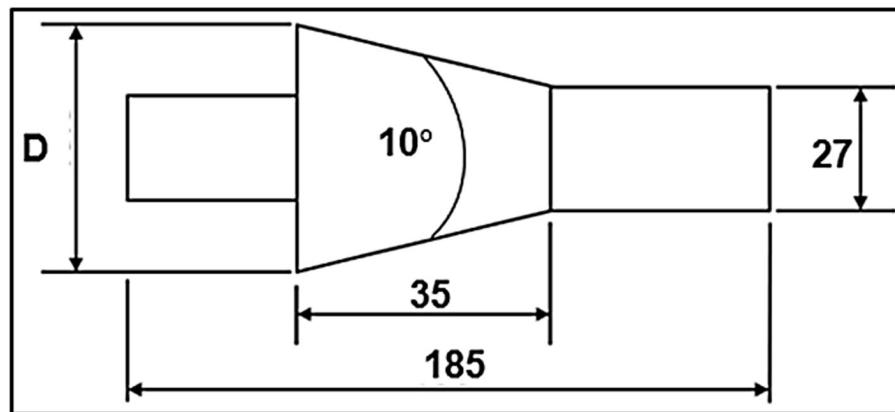


FIGURE 4.5

Calculate the following:

4.5.1	The big diameter of the taper	
		(5)



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4.5.2	The set-over of the tailstock required to cut the taper on the lathe	
		(3)

4.6	Name TWO disadvantages of up-cut milling.	
		(2)

4.7	Calculate the following dimensions of a parallel key suitable for a 102 mm diameter shaft:	
-----	--	--

4.7.1	Width of key	
		(2)

4.7.2	Thickness of key	
		(2)





4.7.3	Length of key	
		(2)

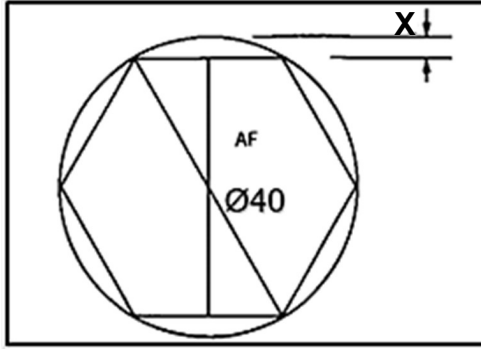
4.8	Name and illustrate, with a sketch, the THREE front views of multi-start screw threads (excluding four-start screw thread).	
		(2)
		(2)
		(2)

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QUESTION 5: TERMINOLOGY (INDEXING) (SPECIFIC)

5.1	A hexagon, as shown in FIGURE 5.1, must be cut on a shaft with a diameter of 40 mm. Calculate the depth (X) required to cut the hexagon on the shaft.	
	 FIGURE 5.1	
		(5)
5.2	A gear with 63 teeth and a module of 3 must be cut on a shaft. Calculate the following:	
5.2.1	Addendum	
		(1)





5.2.2	The pitch circle diameter (PCD)	
		(2)
5.2.3	Clearance	
		(2)
5.2.4	The outside diameter	
		(2)
5.2.5	The cutting depth	
		(2)


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5.4 An internal dovetail must be cut as shown in FIGURE 5.4 below.

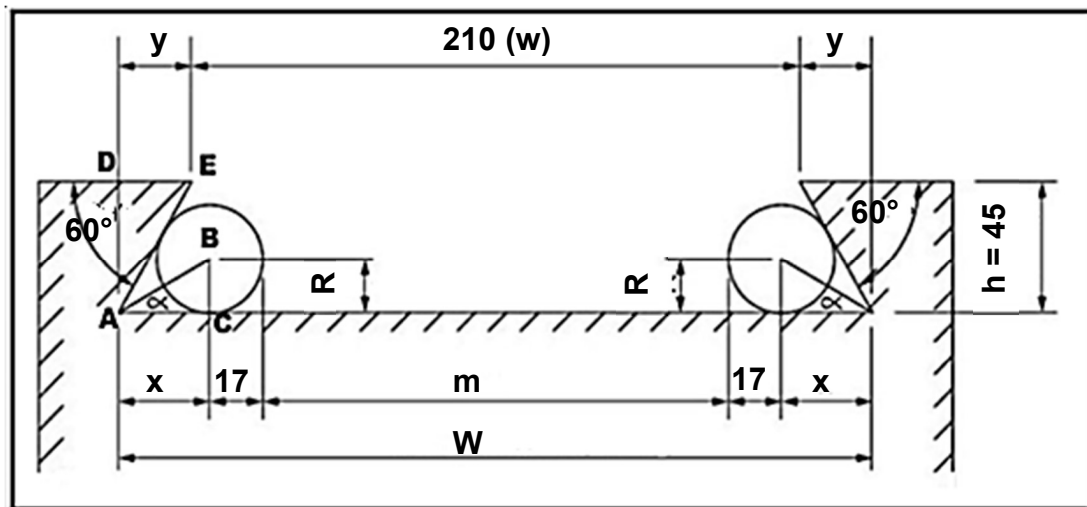


FIGURE 5.4

Calculate the following:

5.4.1 The maximum width (**W**) of the dovetail

(6)



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6.4	Which property of a metal refers to its ability to resist permanent deformation?	
		(1)
6.5	What is the main purpose of the ratchet on a screw-thread micrometer?	
		(1)
6.6	State THREE measures for taking care of a force tester.	
		(3)
6.7	Describe TWO methods of assessing the hardness of metals.	
		(2)


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**MECHANICAL TECHNOLOGY: FITTING
AND MACHINING**

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GR12 0626

6.8 FIGURE 6.8 below shows a diagram of a Brinell hardness tester. Label A – C.

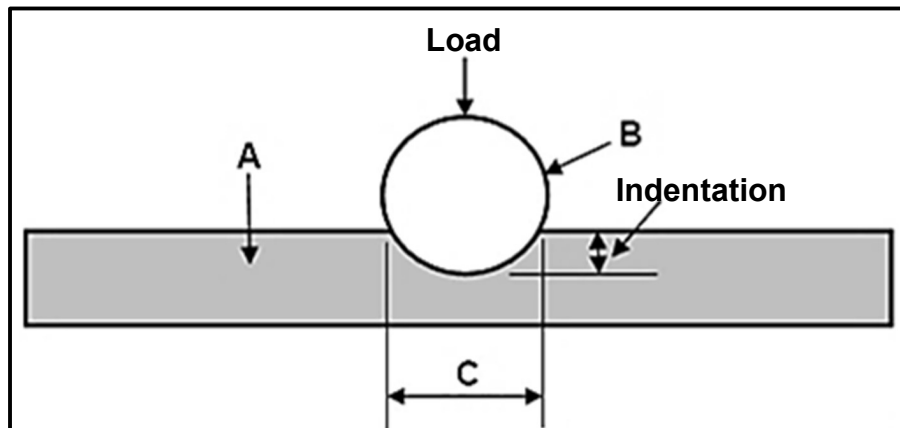


FIGURE 6.8

A.

B.

C.

(3)

6.9 Calculate the cutting depth of a screw thread with a pitch of 1,25 mm.

(2)

6.10 Determine the depth micrometer reading shown in FIGURE 6.10 below.

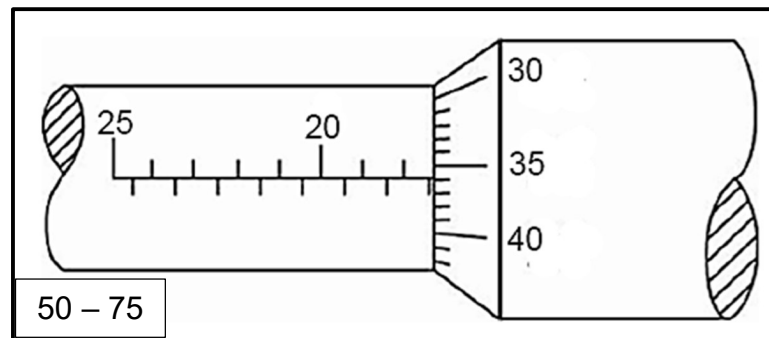


FIGURE 6.10

(3)

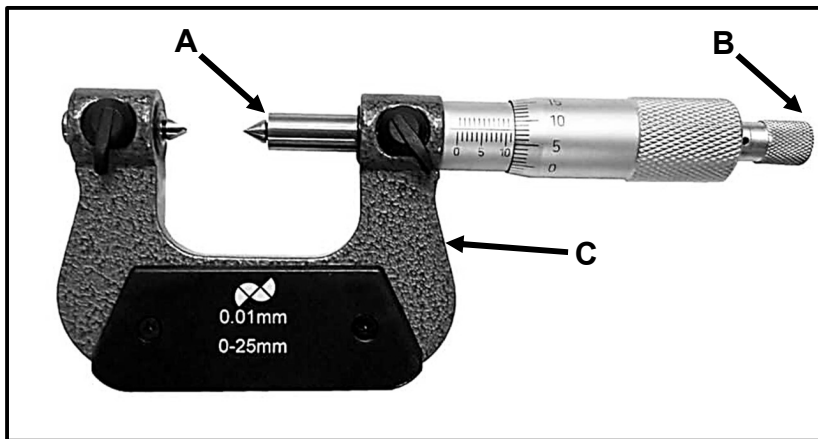


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6.11	What is the difference between a depth micrometer and a screw-thread micrometer with regard to the scales on the barrels of the instruments?	
		(2)

6.12	State the use of a screw-thread micrometer.	
		(2)

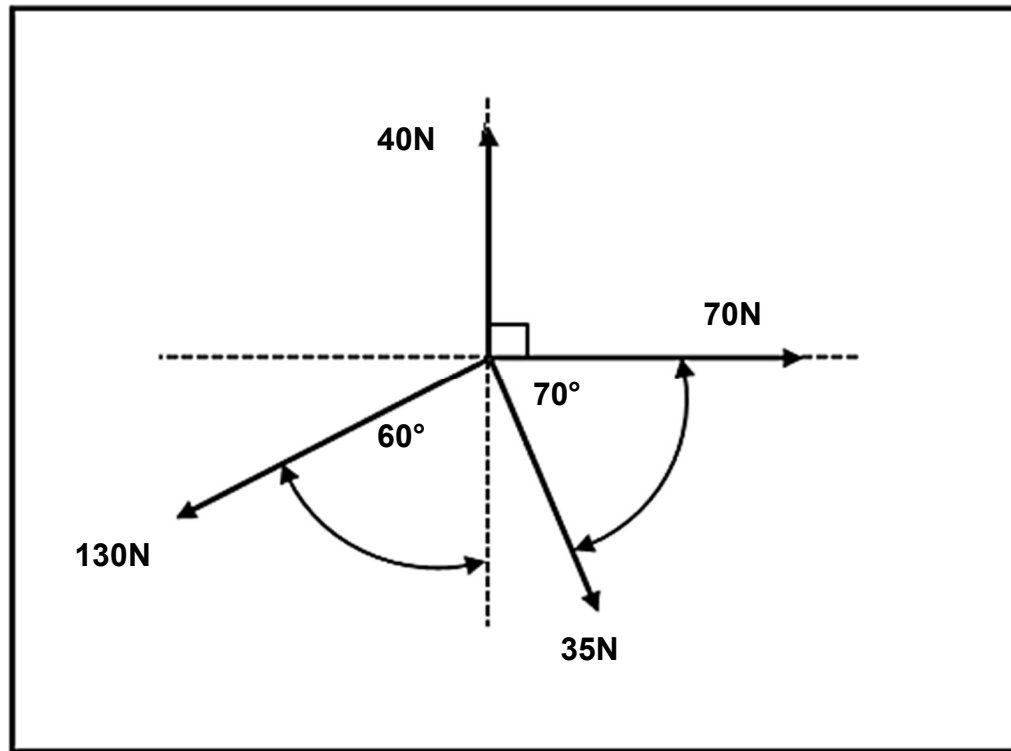
6.13	FIGURE 6.13 below depicts the screw-thread micrometer. Label A – C.	
	 FIGURE 6.13	
	A.	
	B.	
	C.	(3)

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QUESTION 7: FORCES (SPECIFIC)

- 7.1 FIGURE 7.1 below shows four forces at a single point. (**HINT:** Complete the diagram by indicating all horizontal and vertical forces before performing the calculations.)

**FIGURE 7.1**

Calculate the following:

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7.1.3	The angle and direction of the equilibrant	
		(4)

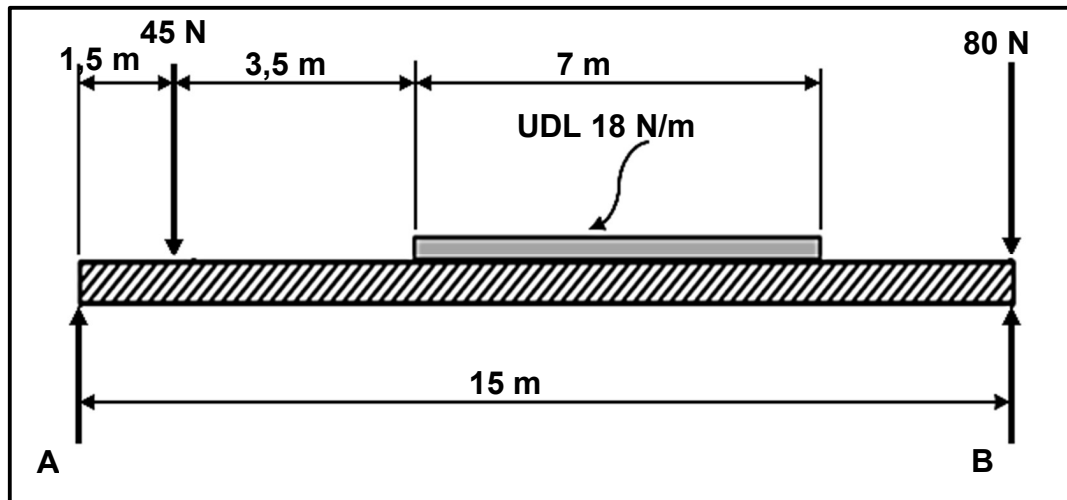
7.2	Define the term <i>strain</i> .	
		(3)


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7.3

FIGURE 7.3 below illustrates a uniform beam resting on two vertical supports, **A** and **B**, with two vertical point loads and a uniformly distributed load (UDL) acting on it.

**FIGURE 7.3**

Calculate the following:

7.3.1

The point load representing the uniformly distributed load (UDL)

(2)

7.3.2

The reactions in supports **A** and **B**

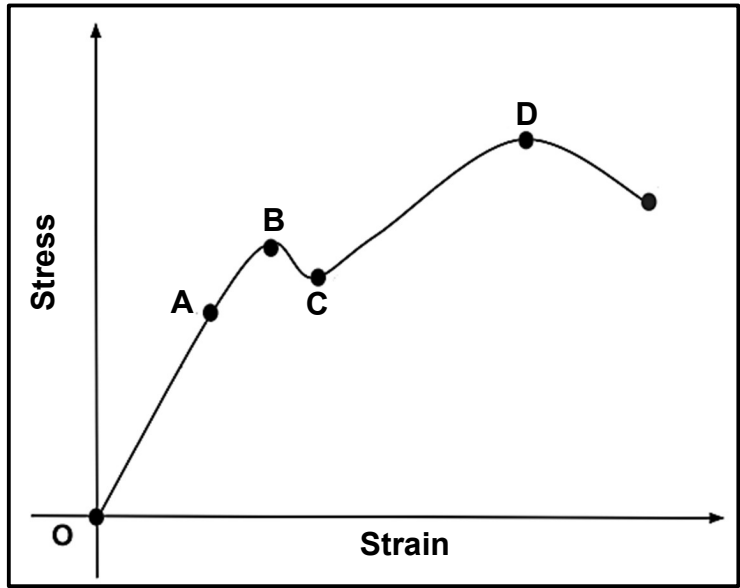
(7)

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7.4.3	The change in length of the bar in mm	
		(4)

7.5	Define <i>Hooke's law</i> .	
		(2)

7.6	A stress-strain diagram is depicted in FIGURE 7.6 below. Label A – D.  FIGURE 7.6	
-----	--	--

	A.	
	B.	
	C.	
	D.	
		(4)




QUESTION 8: MAINTENANCE (SPECIFIC)

8.1	Define the term <i>preventative maintenance</i> in the context of workshop machines.	
		(2)

8.2	Name THREE different types of mechanical drives.	
		(3)

8.3	Name TWO types of belts that are used in belt drive systems.	
		(2)

8.4	Explain why lubrication is an important element of maintenance for machining equipment.	
		(2)





8.5	What is the difference between <i>condition-based maintenance</i> and <i>scheduled maintenance</i> ?	
		(2)
8.6	The chain drive of a machine produces abnormal sounds and repeatedly slips off the gears. Answer the questions that follow.	
8.6.1	Identify TWO likely causes related to poor maintenance.	
		(2)
8.6.2	Name ONE maintenance action to correct the cause.	
		(1)
8.7	Give the reason that polyester resin is used with glass fibre.	
		(1)





8.8	Explain the difference between <i>thermo-hardened</i> and <i>thermoplastic</i> composites.	
		(4)

8.9	State TWO uses of EACH of the following composites:	
-----	---	--

8.9.1	Fibreglass	
		(2)

8.9.2	Bakelite	
		(2)





8.10	Indicate whether EACH of the following materials is a thermo-hardened or a thermoplastic composite:	
8.10.1	Carbon fibre	
		(1)
8.10.2	Nylon	
		(1)
8.10.3	Vesconite	
		(1)

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**MECHANICAL TECHNOLOGY: FITTING
AND MACHINING GR12 0626****32****ADDITIONAL SPACE****SA EXAM PAPERS**

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FORMULA SHEET FOR MECHANICAL TECHNOLOGY: FITTING AND MACHINING

1. BELT DRIVES

$$1.1 \quad \text{Belt speed} = \frac{\pi DN}{60}$$

$$1.2 \quad \text{Speed ratio} = \frac{\text{Diameter of driven pulley}}{\text{Diameter of driver pulley}}$$

$$1.3 \quad \text{Power (P)} = \frac{(T_1 - T_2) \pi D N}{60}$$

Where:

T_1 = force in the tight side

T_2 = force in the slack side

$T_1 - T_2$ = effective tensile force (T_e)

$$1.4 \quad \text{Ratio between tight side and slack side} = \frac{T_1}{T_2}$$

$$1.5 \quad N_{DR} \times D_{DR} = N_{DN} \times D_{DN}$$

$$1.6 \quad \text{Torque} = \text{Force} \times \text{Radius}$$

$$1.7 \quad \text{Power (P)} = \frac{2\pi NT}{60}$$

2. STRESS AND STRAIN

$$2.1 \quad A_{\text{shaft}} = \frac{\pi d^2}{4}$$

$$2.2 \quad A_{\text{pipe}} = \frac{\pi (D^2 - d^2)}{4}$$

$$2.3 \quad \text{Safety factor} = \frac{\text{Maximum stress / Break stress}}{\text{Safe working stress}}$$

$$2.4 \quad \text{Stress} = \frac{\text{Force}}{\text{Area}} \quad \text{OR} \quad \sigma = \frac{F}{A}$$



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$$2.5 \quad \text{Strain} = \frac{\text{Change in length}}{\text{Original length}} \quad \text{OR} \quad \varepsilon = \frac{\Delta L}{oL}$$

$$2.6 \quad \text{Young's modulus} = \frac{\text{Stress}}{\text{Strain}} \quad \text{OR} \quad E = \frac{\sigma}{\varepsilon}$$

3. HYDRAULICS

$$3.1 \quad \text{Pressure} = \frac{\text{Force}}{\text{Area}} \quad \text{OR} \quad P = \frac{F}{A}$$

$$3.2 \quad \text{Volume} = \text{Area} \times \text{Stroke length} \quad (l \text{ or } s)$$

$$3.3 \quad \text{Work done} = \text{Force} \times \text{Distance}$$

$$3.4 \quad P_A = P_B$$

$$3.5 \quad \frac{F_A}{A_A} = \frac{F_B}{A_B}$$

4. GEAR DRIVES

$$4.1 \quad \text{Power (P)} = \frac{2\pi NT}{60}$$

$$4.2 \quad \text{Gear Ratio} = \frac{\text{Product of teeth on driven gear}}{\text{Product of teeth on driver gear}} \quad \text{OR} \quad \text{Speed ratio} = \frac{N_{\text{input}}}{N_{\text{output}}}$$

$$4.3 \quad \frac{N_{\text{input}}}{N_{\text{output}}} = \frac{\text{Product of teeth on driven gear}}{\text{Product of teeth on driver gear}}$$

$$4.4 \quad N_A \times T_A = N_B \times T_B$$

$$4.5 \quad \text{Torque} = \text{Force} \times \text{Radius}$$

$$4.6 \quad \text{Torque transmitted} = \text{Gear ratio} \times \text{Input torque}$$

$$4.7 \quad \text{Module} = \frac{\text{Pitch - circle diameter}}{\text{Number of teeth}} \quad \text{OR} \quad m = \frac{PCD}{T}$$

$$4.8 \quad \text{Pitch - circle diameter} = \frac{\text{Circular pitch} \times \text{Number of teeth}}{\pi} \quad \text{OR} \quad PCD = \frac{CP \times T}{\pi}$$



4.9 *Outside diameter (OD) = PCD + 2(m)*

4.10 *Addendum = Module* **OR** *a = m*

4.11 *Dedendum (b) = 1,157 × m* **OR** *Dedendum (b) = 1,25 × m*

4.12 *Cutting depth (h) = 2,157 × m* **OR** *Cutting depth (h) = 2,25 × m*

4.13 *Clearance (c) = 0,157 × m* **OR** *Clearance (c) = 0,25 × m*

4.14 *Circular pitch (CP) = m × π*

4.15 *Working depth (WD) = 2 × m* **OR** *Working depth (WD) = 2 × a*

5. KEYWAYS

5.1 *Width (W) = $\frac{D}{4}$*

5.2 *Thickness (T) = $\frac{D}{6}$*

5.3 *Length (L) = 1,5 × D*

Where:

D = Diameter of shaft

5.4 *Standard taper for taper key: 1 in 100 or 1 : 100*

6. CINCINNATI DIVIDING HEAD TABLE FOR MILLING MACHINE

Hole circles											
<i>Side 1</i>	24	25	28	30	34	37	38	39	41	42	43
<i>Side 2</i>	46	47	49	51	53	54	57	58	59	62	66
Change gears											
<i>Gears</i>	24 × 2	28	32	40	44	48	56	64	72	86	100

6.1 *Indexing = $\frac{40}{n}$ (n = number of divisions)*



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$$6.2 \quad \frac{Dr}{Dn} = \frac{A-n}{A} \times \frac{40}{1} \quad \text{OR} \quad \frac{Dr}{Dn} = (A-n) \times \frac{40}{A}$$

Where:

A = chosen number of divisions
 n = real number of divisions

7. DOVETAILS

Where:

R = Radius of precision roller
 y = Distance from top edge of dovetail in relation to bottom corner of dovetail
 x = Distance from middle of precision roller to bottom corner of dovetail
 θ = Dovetail included angle (normally 60°)
 h = Height of dovetail
 w = Minimum width of dovetail
 W = Maximum width of dovetail
 m = Distance between rollers
 M = Distance over rollers

8. TAPERS

$$8.1 \quad \tan \frac{\theta}{2} = \frac{D-d}{2 \times l} \quad (l = \text{Taper length})$$

$$8.2 \quad \text{Tail stock set - over} = \frac{L(D-d)}{2 \times l} \quad (L = \text{Distance between centres})$$

9. SCREW THREADS

$$9.1 \quad \text{Mean diameter} = \text{Outside diameter} - \left(\frac{1}{2} \times \text{Pitch}\right) \quad \text{OR} \quad D_m = OD - \frac{P}{2}$$

$$9.2 \quad \text{Effective diameter } (D_{\text{eff}}) = \text{Pitch diameter } (D_p) = \text{Mean diameter } (D_m)$$

$$9.3 \quad \text{Lead} = \text{Pitch} \times \text{Number of starts}$$

$$9.4 \quad \text{Height of screw thread} = 0,866 \times \text{Pitch } (P)$$

$$9.5 \quad \text{Depth of screw thread} = 0,613 \times \text{Pitch } (P)$$



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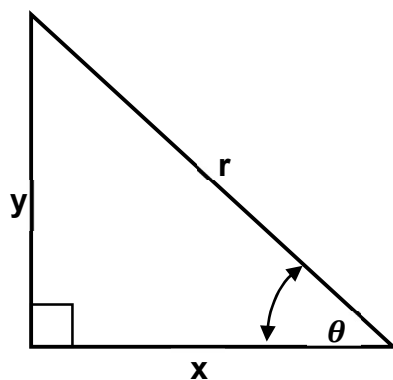
9.6 Helix angle: $\tan \theta = \frac{\text{Lead}}{\pi \times D_m}$

9.7 Leading angle = $90^\circ - (\text{Helix angle} + \text{Clearance angle})$

9.8 Following angle = $90^\circ + (\text{Helix angle} - \text{Clearance angle})$

9.9 $D_P = D_N - (0,866 \times P)$

10. PYTHAGORAS' THEOREM AND TRIGONOMETRY



10.1 $\sin \theta = \frac{y}{r}$

10.2 $\cos \theta = \frac{x}{r}$

10.3 $\tan \theta = \frac{y}{x}$

10.4 $r^2 = x^2 + y^2$



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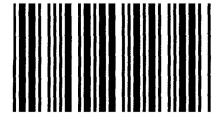


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GRADE 12

2026