



MECHANICAL TECHNOLOGY

Time: 3 hours

200 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of 14 pages and a formula sheet of 4 pages (i–iv). Please check that your question paper is complete.
2. Read ALL the questions carefully.
3. Answer all the questions.
4. Number the answers correctly according to the numbering system used in this paper.
5. Start EACH question on a NEW page.
6. Show ALL calculations and units. Round off final answers to TWO decimal places.
7. Candidates may use non-programmable, scientific calculators and drawing instruments.
8. Take the value of gravity to be 10 m/s^2 .
9. All dimensions are in millimetres, unless stated otherwise in the question.
10. Write neatly and legible.
11. Use the criteria below to help you manage your time.

QUESTION	CONTENTS	MARKS	TIME (minutes)
1	Multiple-choice Questions	20	15
2	Safety	10	10
3	Tools and Equipment	12	10
4	Materials	13	10
5	Terminology	30	20
6	Joining Methods	25	25
7	Forces	30	30
8	Maintenance	15	15
9	Systems and Control	25	25
10	Turbines	20	20
TOTAL		200	180

QUESTION 1 MULTIPLE-CHOICE QUESTIONS

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

- 1.1 Which ONE of the following safety measures is applicable to an angle grinder?
- A The work area must be open to other workers.
 - B Grinding wheel may be forced against an object.
 - C Grinding wheel may not have cracks.
 - D Any type of grinding wheel may be used for grinding.
- 1.2 Which ONE of the following safety measures is applicable to a torsion tester?
- A Beware of metal particles that come off after torquing.
 - B Bolts of the correct strength must be used on the frame.
 - C The rotating test piece may be stopped by hand.
 - D Use a strong lever to torque the test piece.
- 1.3 When continuity in a circuit is tested, the test leads must be in the following sockets:
- A Red 10A DC socket, black COM socket
 - B Red $V\Omega mA$ socket, black COM socket
 - C Red COM socket, black 10A DC socket
 - D Red COM socket, black $V\Omega mA$ socket
- 1.4 FIGURE 1.1 shows a milling cutter. Which type of milling can usually be done with this milling cutter?

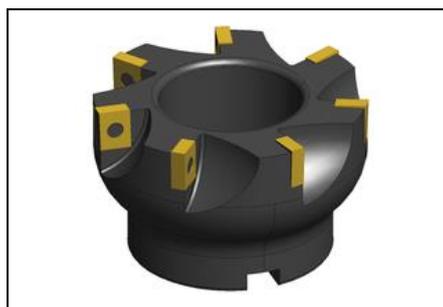


FIGURE 1.1

- A Straddle milling
- B Gang milling
- C Slot milling
- D Face milling

1.5 When carbon steel is heated at a constant rate, its temperature rises to 720 °C where the temperature then remains constant. This point is called the ...

- A recalescence point.
- B cooling point.
- C decalescence point.
- D lower critical point.

1.6 Which structure of steel is characterised by the property of good malleability?

- A Austenite
- B Cementite
- C Pearlite
- D Ferrite

1.7 A shaft with a diameter of 48 mm will need a key of length ... mm.

- A 42
- B 52
- C 62
- D 72

1.8 Identify the milling process shown in FIGURE 1.2.

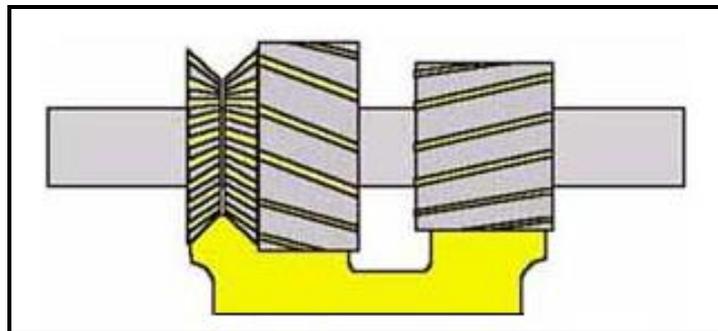


FIGURE 1.2

- A Gang milling
- B Face milling
- C Slot milling
- D Straddle milling

1.9 The purpose of a flow meter is to regulate ...

- A the flow rate of shielding gas.
- B the rate of the filling material.
- C the amperes per hour.
- D continuous wire feed.

- 1.10 The X-ray test can detect the following defects in welding joints:
- A Only internal defects.
 - B Only external defects.
 - C Only surface defects.
 - D All defects in a welding joint.
- 1.11 The axis of a screw thread may be defined as the ...
- A centre line through the screw thread's crest.
 - B centre line through the screw thread's pitch.
 - C centre line through the screw thread's width.
 - D centre line through the screw thread in the length.
- 1.12 What will Young's elasticity modulus for a metal be if the strain value, caused by a tension of 6 MPa, is 2×10^{-3} ?
- A 3×10^3 Pa
 - B 3×10^6 Pa
 - C 3×10^3 MPa
 - D 3×10^6 MPa
- 1.13 What is the unit of a stress?
- A Pa
 - B KPa
 - C MPa
 - D GPa
- 1.14 Which of the properties below is most suitable for oil that is used in a hypoid type of differential?
- A Absorbs high shock loads.
 - B Lubricates.
 - C Reduces friction.
 - D All of the above.
- 1.15 The definition of the viscosity index of oil is a measurement of how much the viscosity of the oil changes when the ... changes.
- A temperature
 - B pressure
 - C flow
 - D resistance

1.16 Work done is measured in ...

- A Joules.
- B Newtons.
- C Watts.
- D Kilowatts.

1.17 With ABS brakes a current is generated in the stator windings. Which type of current is usually used?

- A Direct current
- B Alternating current
- C Single current
- D Double current

1.18 Which ONE of the following is an advantage of a flat-belt drive system compared to a gear drive system?

- A It can transmit power only over short distances.
- B It can slip on the pulley.
- C It needs no lubrication.
- D It cannot change the direction of rotation.

1.19 How is a turbocharger driven?

- A Exhaust system
- B Inlet system
- C Fuel system
- D Electrical system

1.20 FIGURE 1.3 shows an airbag inflating device. Identify component A.

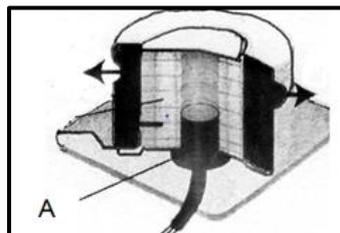


FIGURE 1.3

- A Air pump
- B Igniter
- C Filter
- D Nitrogen

[20]

QUESTION 2 SAFETY

- 2.1 List any THREE pieces of equipment for personal safety that you should wear when you are working with a spot welder. (3)
- 2.2 List THREE specific safety measures that you should adhere to when you are using a tensile tester. Do not include personal safety in your answer. (3)
- 2.3 Valves and valve springs must be reinstalled in a cylinder head. Name TWO safety measures that you should adhere to when you are working with a valve spring compressor. (2)
- 2.4 Name any TWO safety measures that you should consider when you are working with a bearing and gear puller. (2)

[10]

QUESTION 3 TOOLS AND EQUIPMENT

3.1 Equipment is very important to complete various tasks in the workplace. Explain the function of and reason for using EACH of the following testers:

3.1.1 Oil pressure tester (2)

3.1.2 Hardness tester (2)

3.1.3 Torsion tester/torque tester (2)

3.2 Calculate the reading on the screw thread micrometer shown in Figure 3.1 below.

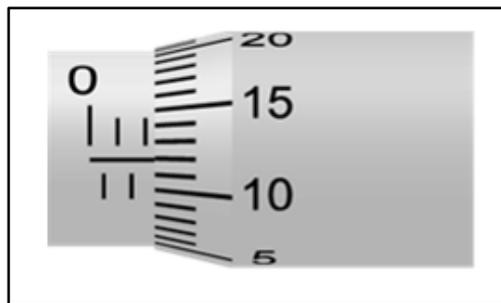


FIGURE 3.1

(2)

3.3 In FIGURE 3.2 a cylinder leakage test is performed after the owner of the vehicle has complained about the performance of his vehicle.

Name TWO possible problems that may be diagnosed with the test.

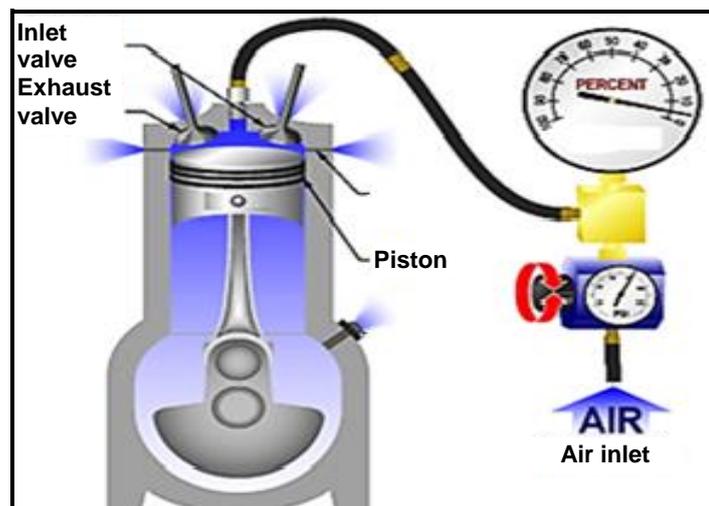


FIGURE 3.2

(2)

3.4 Name any TWO tests that may be performed with a multimeter.

(2)

[12]

QUESTION 4 MATERIALS

- 4.1 Draw a neat iron-carbon equilibrium diagram and indicate the following on the diagram:
- 4.1.1 AC_3 line (2)
 - 4.1.2 Ferrite + Austenite structure (2)
 - 4.1.3 Ferrite + Pearlite structure (2)
 - 4.1.4 Temperature in degrees Celsius (1)
 - 4.1.5 Carbon content percentages (1)
 - 4.1.6 Austenite structure (1)
- 4.2 The nitration process is used on crankshafts. Explain the advantages that are obtained in relation to the crankshaft surface. (2)
- 4.3 Why are the cams on the camshaft machined and hardened? (2)
- [13]**

QUESTION 5 TERMINOLOGY

- 5.1 A Gib head key must be manufactured to fit into a shaft with a diameter of 70 mm.
- Calculate the following:
- 5.1.1 Width of key (2)
- 5.1.2 Thickness of key (2)
- 5.1.3 Length of key (2)
- 5.2 Name the type of milling cutter that is used to cut a spur gear. (2)
- 5.3 Explain the disadvantages when the carriage method is used to cut an external metric V-thread on a centre lathe. (2)
- 5.4 Calculate the indexing needed to cut a 76-tooth gear. (4)
- 5.5 Name TWO advantages of up-cut milling. (2)
- 5.6 For what purpose is the straddle-milling method used? (2)
- 5.7 Explain the steps you would use to set up a milling machine to cut a keyway. You may use a sketch to help you with your explanation of the steps. (Any 7 steps.) (7)
- 5.8 Explain the function of a screw thread micrometer. (2)
- 5.9 The lead of a screw thread is ... (complete) (3)
- [30]**

QUESTION 6 JOINING METHODS

- 6.1 Shielding gas is used with the MIG/MAGS welding process. Explain what the function of the shielding gas is. (2)
- 6.2 Explain the relationship between the voltage (V) and the wire feed during the MIG/MAGS welding process. (3)
- 6.3 Porosity in a welding joint refers to gas pores in a solidified crack welding joint. List FOUR causes of porosity in a MIG welding joint. (4)
- 6.4 Name TWO precautions for EACH of the following welding defects:
- 6.4.1 Porosity (2)
- 6.4.2 Lack of fusion (2)
- 6.5 Give ONE reason for performing the following destructive tests:
- 6.5.1 Free-bend test/Nick-bend test (2)
- 6.5.2 Nick-break test (2)
- 6.6 What is the advantage of ultrasonic testing on a welding joint as opposed to other similar tests that can be performed? (2)
- 6.7 An experienced welder will conduct a visual inspection of the welding joint during and after welding. List any FOUR visual requirements that are needed to make it an acceptable welding joint. (4)
- 6.8 What is the function of the transmitter-receiver unit as used in the ultrasonic test on a welding joint? (2)

[25]

QUESTION 7 FORCES

7.1 FIGURE 7.1 represents the space diagram of a system of forces in which four different forces act on a steel pin (x). Three forces of 160 N, 200 N and 75 N, respectively, apply a tensile force on the pin. A single force of 90 N applies a compressive force on the steel pin (x).

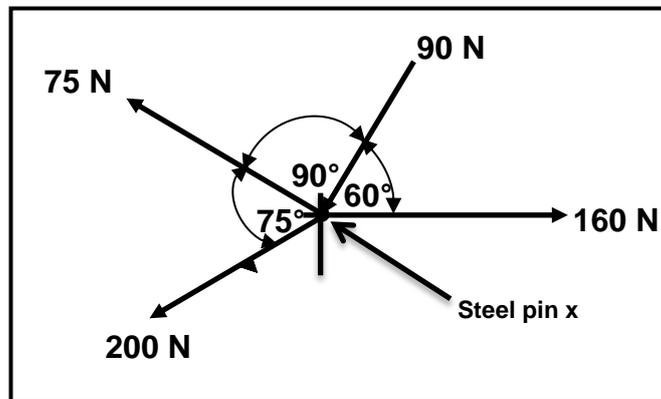


FIGURE 7.1

Calculate the following:

- 7.1.1 The sum of vertical and horizontal components (10)
- 7.1.2 The resultant force (4)
- 7.1.3 Direction of the resultant force (4)
- 7.2 An unknown force causes 5,2 MPa stress in a round bar of 35 mm. Calculate the magnitude of the force. (4)
- 7.3 Study the stress-strain graph in FIGURE 7.2. Label point E as indicated on the graph.

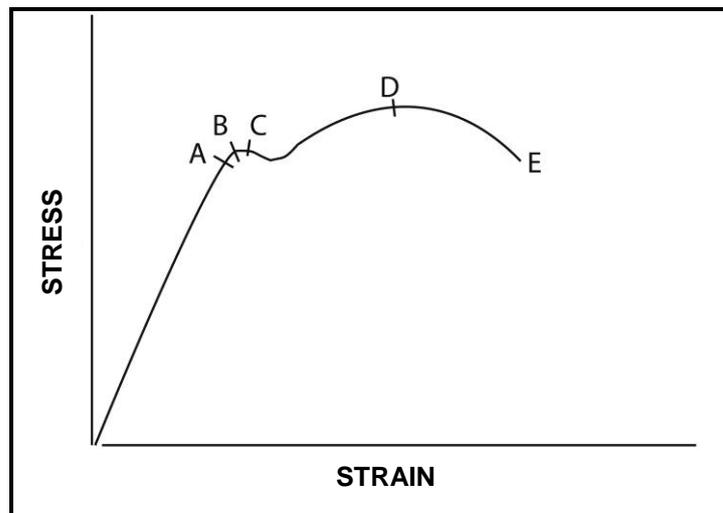


FIGURE 7.2

(1)

7.4 FIGURE 7.3 shows a uniform beam that is supported by two vertical supports, A and B. Two vertical point loads are exerted on the beam, as well as an uniformly distributed load of 50 N/m on the distance between the two vertical point loads.

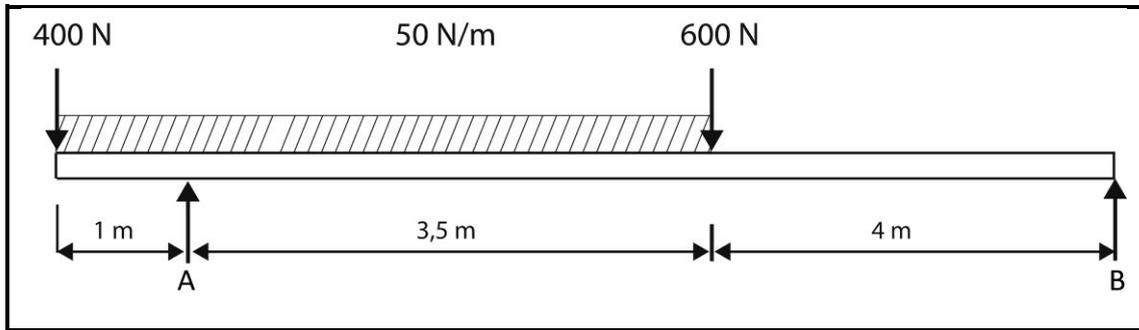


FIGURE 7.3

Using calculations, determine the magnitudes of the reactions in support A and support B.

(7)
[30]

QUESTION 8 MAINTENANCE

- 8.1 Define preventative maintenance. (3)
 - 8.2 Which institute is regarded as the world's authoritative body in oil classification? (1)
 - 8.3 Define the term *pour point* of a lubricant. (2)
 - 8.4 State the mixture that cutting fluid consists of. (2)
 - 8.5 Explain why it is important to maintain a belt drive system. (2)
 - 8.6 Explain the reason for skimming the flywheel before a new clutch plate is installed. (3)
 - 8.7 Explain why hypoid gears are difficult to lubricate. (2)
- [15]

QUESTION 9 SYSTEMS AND CONTROL

9.1 The system of gears in FIGURE 9.1 is used to control a mechanical gate. The driving gear has 40 teeth and rotates at 600 r/min. The idler gear that is used to change the direction of rotation rotates at 800 r/min. The driven gear has 60 teeth.

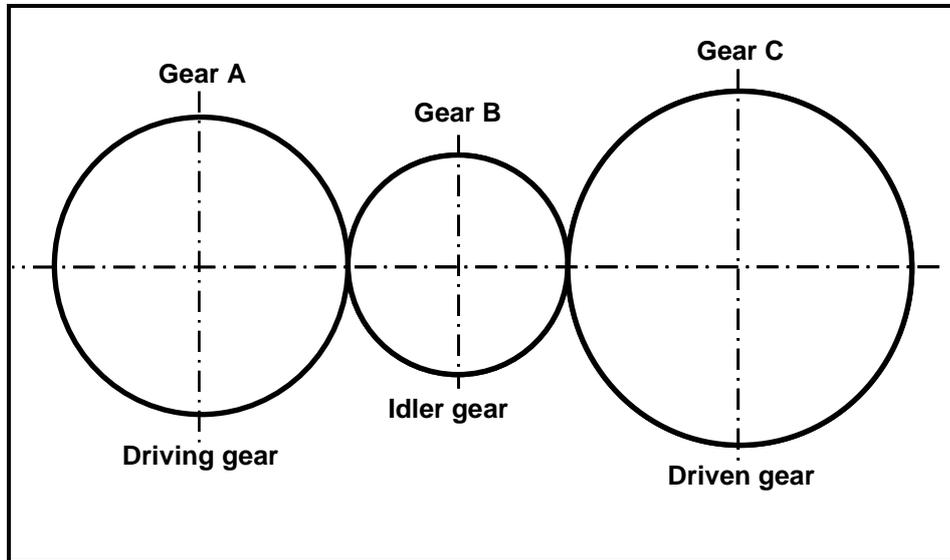


FIGURE 9.1

Using calculations, determine:

- 9.1.1 The number of teeth on the idler gear. (3)
- 9.1.2 The rotation frequency of the driven gear in revolutions per minute. (3)

9.2 A machine must be driven at a speed of 14 r/s from a pulley with a diameter of 700 mm rotating at a speed of 8,2 r/s. The tensile force in the tight side of the belt is 400 N. The ratio between the tensile force in the tight side and the tensile force in the slack side is 2,5 : 1.

Using calculations, determine:

- 9.2.1 The diameter of the pulley that must be fitted on the machine. (3)
- 9.2.2 The power that can be transmitted. (3)

9.3 A hydraulic system is used in a hydraulic press. The specifications of the system are represented diagrammatically in FIGURE 9.2.

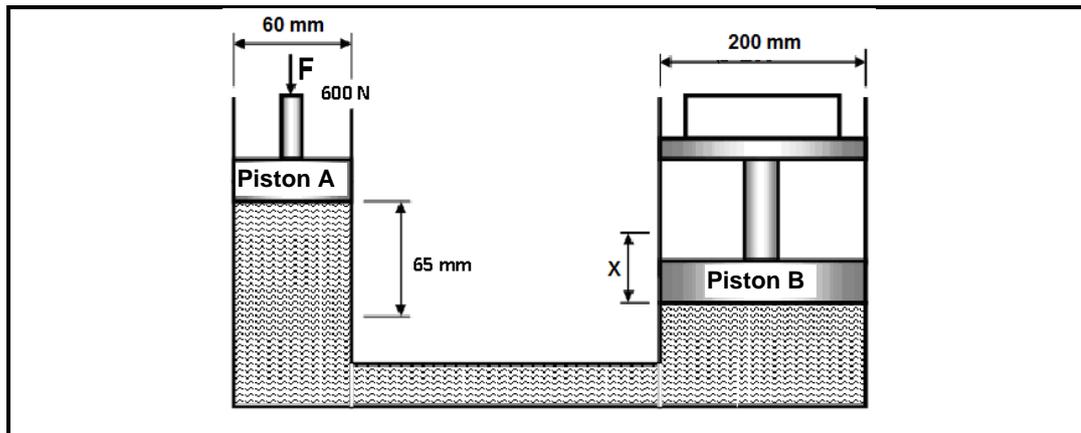


FIGURE 9.2

Using calculations, determine:

9.3.1 The pressure in the system. (5)

9.3.2 The distance (X) that piston B will move when piston A moves 65 mm downwards. (6)

9.4 Explain why airbags in a motor vehicle may be regarded as a passive safety feature. (2)
[25]

QUESTION 10 TURBINES

10.1 Name TWO types of reaction turbines. (2)

10.2 Explain the term "runaway speed" referring to a turbine. (2)

10.3 Why is it important to control the speed of a steam turbine? (2)

10.4 List THREE advantages of a gas turbine. (3)

10.5 Name the TWO sections that make up a turbocharger. (2)

10.6 Explain what is meant by "volumetric efficiency". (2)

10.7 What effect does a high altitude above sea level have on the performance of a motor vehicle engine? (2)

10.8 Discuss the advantages of a centrifugal type of charger over the double-screw type of charger when the TWO types are compared. (3)

10.9 What is the purpose of a "recuperator" as found in a gasturbine? (2)
[20]

TOTAL: 200 marks