basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

MECHANICAL TECHNOLOGY

EXEMPLAR 2014

MARKS: 200

TIME: 3 hours

This question paper consists of 18 pages and a 3-page formula sheet.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the spaces provided 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. Candidates may use non-programmable scientific calculators and drawing instruments.
8. Take the value of gravitational force as 10 m/s^2.
9. All dimensions are in millimetres, unless stated otherwise in the question.
10. A formula sheet for your use is attached at the back of this question paper.
11. Write neatly and legibly.
12. Use the criteria below to assist you in managing your time.

QUESTION	CONTENT	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 provided as possible answers to the following questions. Choose the answer and write 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 What safety measure is applicable to the milling machine in terms of the Occupational Health and Safety Act?

A Do not apply a wrench to revolving work.
B Guards could be removed when cutting soft material.
C Make sure the wheel is dressed.
D Use the machine table as an anvil. (1)

1.2 Which ONE of the following safety procedures is applicable to the cylinder leakage tester?

A Use water to remove dust around the spark-plug area.
B Clean the oil-filler cap.
C Do not exceed the prescribed pressure in the cylinder.
D The tester must be well tightened until no hissing sounds can be heard. (1)

1.3 What is the function of a gas analyser?

A Analyse inlet gases
B Analyse oil gases
C Analyse fuel gases
D Analyse exhaust gases (1)

1.4 A Brinell tester is used to test the ... of a material.

A tension
B elasticity
C hardness
D brittleness (1)

1.5 What will be the result when steel is heated in the second phase AC_2?

A Grain structure is at its smallest.
B It will become liquid.
C It only loses its magnetism.
D It becomes a stronger magnet. (1)

1.6 Which ONE of the following is a property of pearlite?

A It is ductile.
B It is weak.
C It is malleable.
D It becomes brittle. (1)

1.7 Identify the type of key shown in FIGURE 1.1.

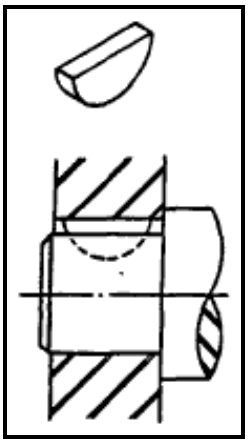

FIGURE 1.1

A Square key
B Gib head key
C Pratt and Whitney key
D Woodruff key (1)

1.8 Which milling method is shown in FIGURE 1.2?

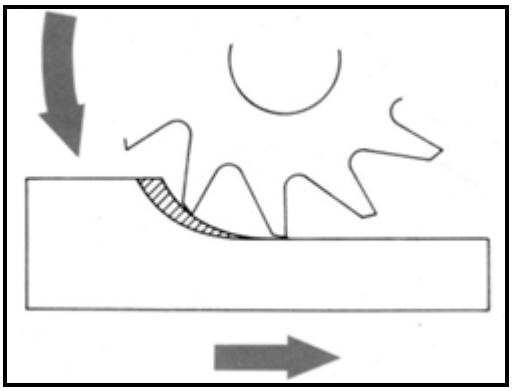

FIGURE 1.2

A Down-cut milling
B Up-cut milling
C Gang milling
D Straddle milling (1)

1.9 How are defects shown by applying an X-ray test?

A Defects visible on the weld
B Defects visible on film
C Defects determined by sound
D Defects visible on an oscilloscope screen (1)

1.10 What is the reason for applying a nick-break test on a welded joint?

A To test the skill of the welder
B To check the size of the weld
C To train welders
D To approve welds and welders to certain standards (1)

1.11 What do you understand by the term *stress* in materials? Internal force in a material resisting a/an ...

A shearing load.
B pulling load.
C compressive load.
D external load. (1)

1.12 Tensile stress can be defined as an internal force in a material resisting …

A a shearing load.
B a pulling load
C a compressive load.
D any load. (1)

1.13 What do you understand by the term *Young's modulus of elasticity*?

A The force value required to produce a unit area in a tensile test specimen
B The ratio between stress and strain in a metal, provided that the limit of elasticity is not exceeded
C A measurement of the extension or contraction of material due to the load experienced
D A ratio of the deformation because of the application of an external force (1)

1.14 What do you understand by the term *viscosity*? Resistance of a fluid to ...

A an external load.
B heat.
C flow.
D internal stress. (1)

1.15 SAE 20W50 oil is used for …

A engine lubrication.
B gearbox lubrication.
C differential lubrication.
D automatic gearbox lubrication. (1)

1.16 Which ONE of the following statements defines Boyle's law? An ideal gas law where, ...

A at constant pressure, the volume of an ideal gas is inversely proportional to its absolute temperature
B at constant volume, the temperature of an ideal gas is inversely proportional to its absolute pressure
C at constant temperature, the volume of an ideal gas is inversely proportional to its absolute pressure
D at constant temperature, the volume of an ideal gas is directly proportional to its absolute pressure (1)

1.17 What is the velocity ratio of the pulley system in FIGURE 1.3 if pulley A is the driver?

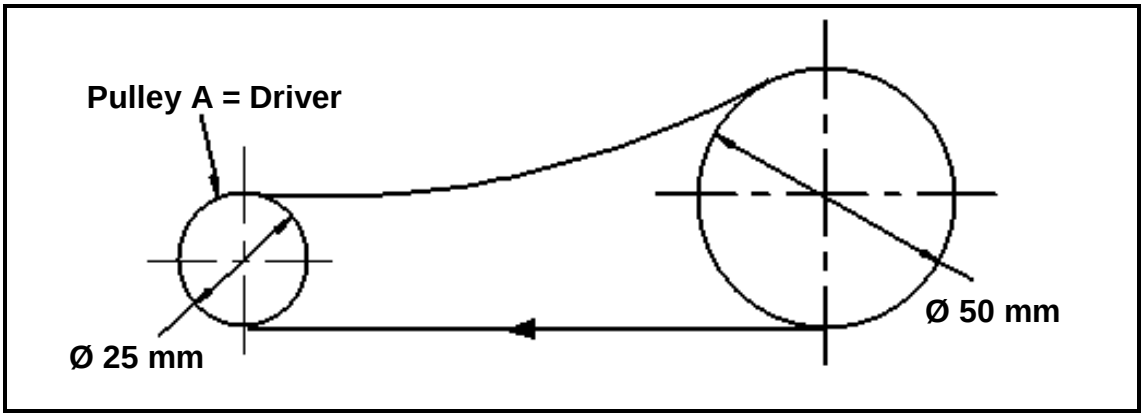

FIGURE 1.3

A 1 : 1
B 3 : 1
C 1 : 2
D 2 : 1 (1)

1.18 Determine the width of a key if the diameter of the shaft is 60 mm.

A 15 mm
B 30 mm
C 20 mm
D 6 mm (1)

1.19 What do you understand by the term *boost* as related to superchargers?

A The pressure the supercharger makes in the inlet manifold
B Where the blower is positioned before the carburettor or throttle body
C The centrifugal force of the air to make compression
D Where the blower is positioned after the carburettor or throttle body (1)

1.20 Identify the hydro-turbine in FIGURE 1.1.

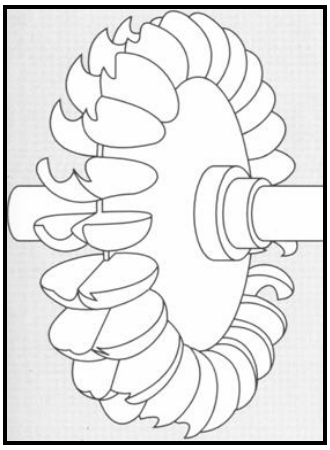

FIGURE 1.1

A Francis
B Pelton
C Kaplan
D Turgo (1)

[20]

QUESTION 2: SAFETY

2.1 State FOUR safety measures to be observed while the lathe is in operation after it has been switched on. (4)

2.2 State THREE safety rules to be applied when using the torsion tester. (3)

2.3 State THREE common safety measures to be observed with arc and gas welding. (3)

[10]

QUESTION 3: TOOLS AND EQUIPMENT

3.1 Mr Jack conducted a compression test on a four-cylinder petrol engine. He found that cylinder two had a lower compression than the other cylinders. State TWO causes for low compression. (2)

3.2 Princess uses the Brinell hardness tester to test the hardness of a specimen given to her by the supervisor. FIGURE 3.1 shows the specimen under test.

Write down the letters A–D in your ANSWER BOOK and the correct names of the parts next to the corresponding letters.

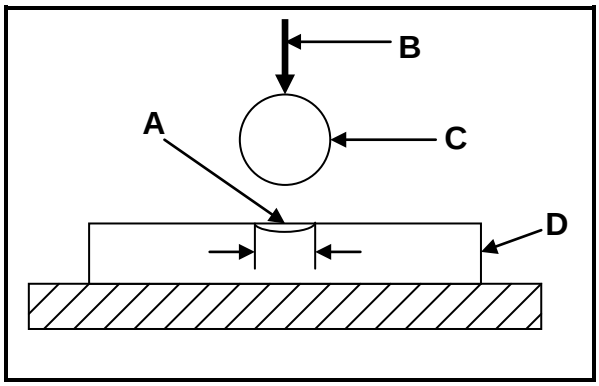

FIGURE 3.1 (4)

3.3 Describe the purpose of the tests below.

3.3.1 Gas analysing test (2)

3.3.2 Beam-bending test (2)

3.4 Mr Raj did a cylinder leakage test and obtained certain results. State ONE possible result and the fault of the cylinder. (2)

[12]

QUESTION 4: MATERIALS

4.1 Name ONE property of each of the structures below.

4.1.1 Ferrite (2)

4.1.2 Cementite (2)

4.1.3 Austenite (2)

4.2 FIGURE 4.1 shows a diagram. Answer the questions that follow.

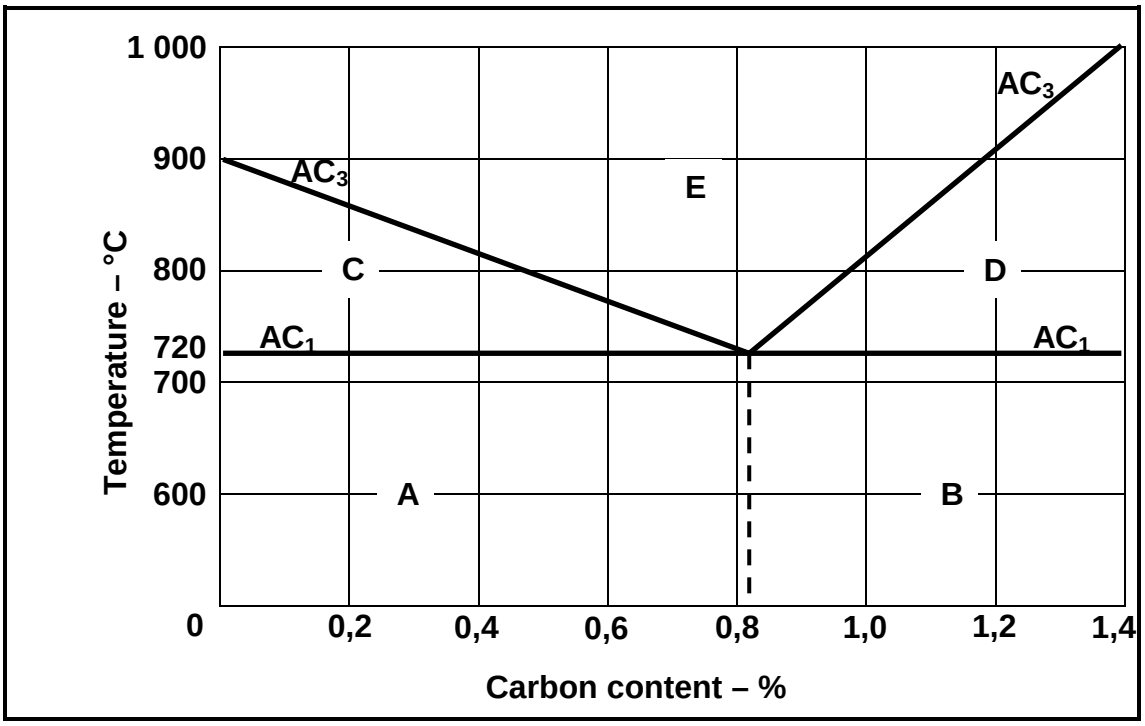

FIGURE 4.1

4.2.1 What type of diagram is shown in FIGURE 4.1? (2)

4.2.2 Write down the letters A–E in your ANSWER BOOK and then the correct labels for the diagram next to the corresponding letters. (5)

[13]

QUESTION 5: TERMINOLOGY

5.1 Explain the *screw-cutting procedure* using the compound-slide method. (7)

5.2 A gib head key must be made to fit a 84 mm diameter shaft. Calculate the following:

5.2.1 The width of the key (2)

5.2.2 The thickness of the key (2)

5.2.3 The length of the key (2)

5.2.4 The thickness of the key at the small end (4)

5.3 State TWO advantages of EACH of the following milling operations:

5.3.1 Up-cut milling (2)

5.3.2 Down-cut milling (2)

5.4 A gear with 17 teeth has to be machined on a milling machine. Calculate the indexing required. (4)

5.5 FIGURE 5.1 shows a milling procedure. Answer the questions that follow.

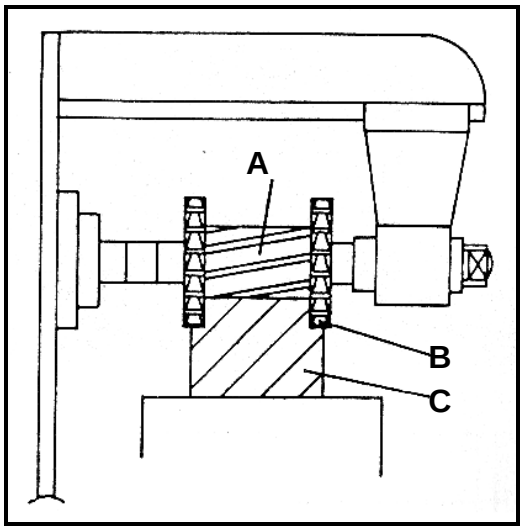

FIGURE 5.1

5.5.1 Identify the milling process. (2)

5.5.2 Write down the letters A–C in your ANSWER BOOK and the correct names of the parts next to the corresponding letters. (3)

[30]

QUESTION 6: JOINING METHODS

6.1 For EACH of the following welded joints, identify the defect, state ONE possible cause and ONE preventive action:

6.1.1 Gas is trapped in the weld metal. (3)

6.1.2 Non-metallic solids are trapped in the weld metal. (3)

6.1.3 A groove appears in the parent metal, directly along the edges of the weld. (3)

6.2 Name THREE destructive tests exerted onto metals. (3)

6.3 Explain how you will conduct a dye penetration test on a welded joint. (7)

6.4 What does the abbreviation *MAG/MIGS* stand for in terms of welding equipment? (1)

6.5 Name FOUR basic components of a MAG/MIGS welding machine. (2)

6.6 State THREE advantages of using a MAG/MIGS welding machine. (3)
[25]

QUESTION 7: FORCES

7.1 Define the concepts below.

7.1.1 Stress (2)

7.1.2 Strain (2)

7.2 Four forces of 9 N, 11 N, 10 N and 8 N as shown in FIGURE 7.1 are acting onto the same point. Determine by means of calculations the equilibrant for the system of forces in FIGURE 7.1.

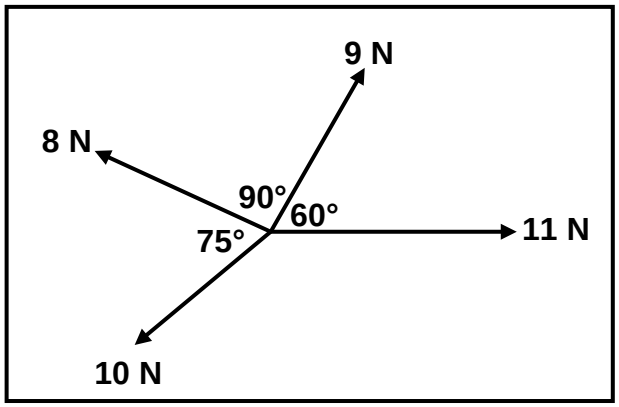

FIGURE 7.1 (13)

7.3 A compressive force causes internal stress of 16 MPa in a round bar made of an unknown metal. The resistance area of the round bar is 1,26 x 10^{-3} m^2 and the original length is 80 mm. The force causes the round bar to shorten by 14,4 x 10^{-3} mm.

Determine by means of calculations:

7.3.1 The strain in the metal caused by the force (3)

7.3.2 The elasticity modulus for this metal (3)

7.4 What does point D represent in FIGURE 7.3?

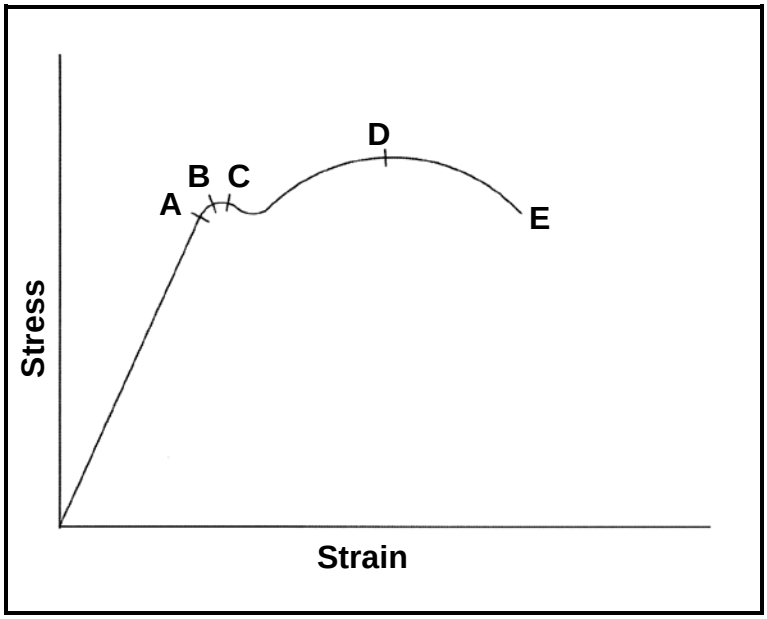

FIGURE 7.3 (1)

7.5 FIGURE 7.4 shows a uniform beam that is supported by two vertical supports, A and B. A uniformly distributed force is exerted on the beam over a distance of 4 m from the left side of the beam. Determine by means of calculations the magnitudes of the reactions in supports A and B.

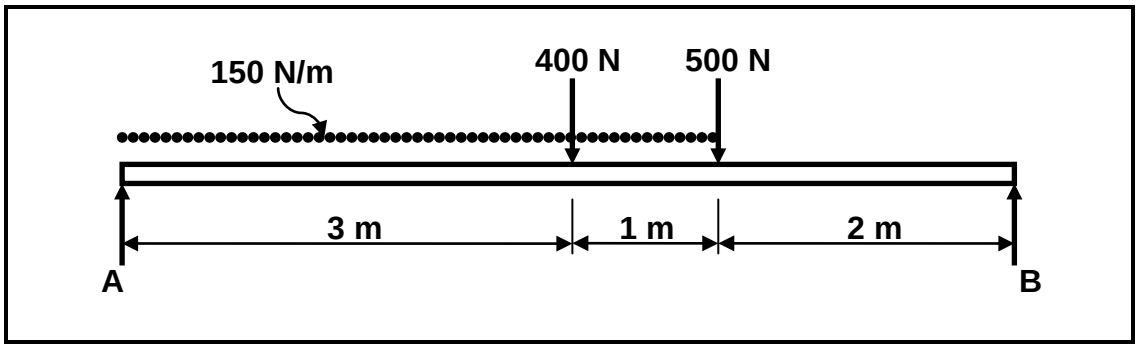

FIGURE 7.4 (6)
[30]

QUESTION 8: MAINTENANCE

8.1 Explain the following properties of oils:

8.1.1 Viscosity (1)

8.1.2 Pour point (1)

8.2 Mr Sunir owns an old car. He does not keep proper service records of his car. This resulted in his car not being serviced on time, causing the timing chain to become noisy. Answer the questions that follow.

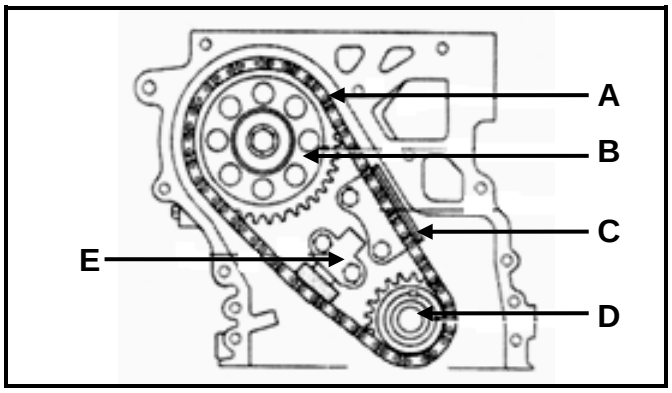

FIGURE 8.1

8.2.1 Write down the letters A–E in your ANSWER BOOK and then the correct labels for the figure next to the corresponding letters. (5)

8.2.2 Explain how you would go about replacing the timing chain. (6)

8.3 What does the abbreviation *SAE* stand for regarding oils? (2)
[15]

QUESTION 9: SYSTEMS AND CONTROL

9.1 FIGURE 9.1 shows a gear drive system. Driver gear A on the shaft of an electric motor has 20 teeth and meshes with gear B with 36 teeth on a countershaft. On this countershaft is another driver gear, C, with 18 teeth that meshes with gear D with 46 teeth on a second countershaft. The second countershaft has a driver gear, E, with 42 teeth that drive gear F with 80 teeth on the output shaft.

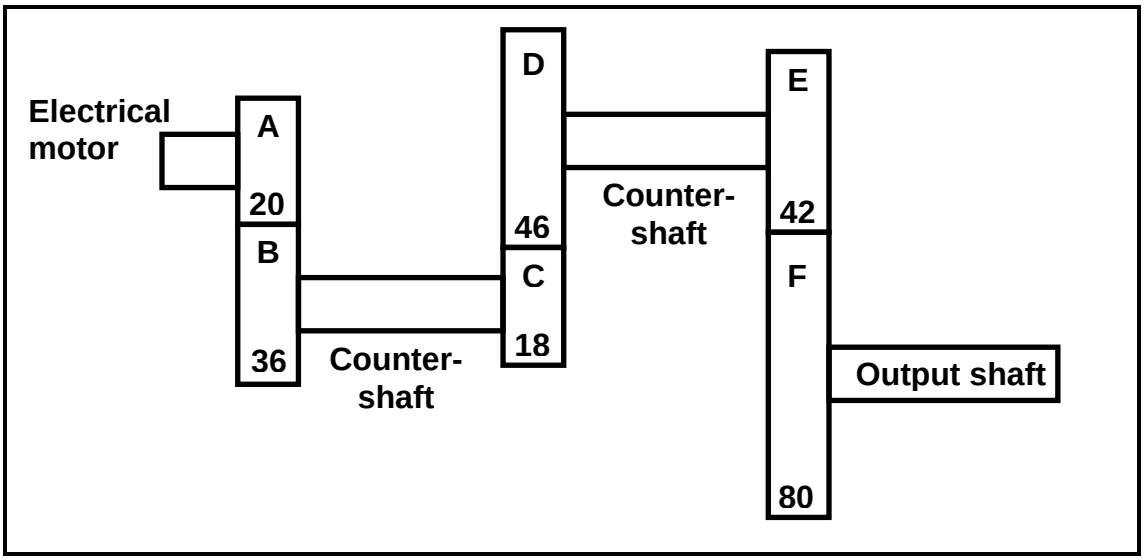

FIGURE 9.1

Determine by means of calculations:

9.1.1 The rotation frequency of the output shaft if the electric motor rotates at 1 440 r/min (revolutions per minute) (3)

9.1.2 The velocity ratio between the input shaft and output shaft (2)

9.2 FIGURE 9.2 shows a belt-drive system. A pulley with a diameter of 0,24 m drives a driven pulley with a diameter of 0,36 m. The driver pulley rotates at 1 100 r/min. T_1 = 200 N and T_2 = 90 N.

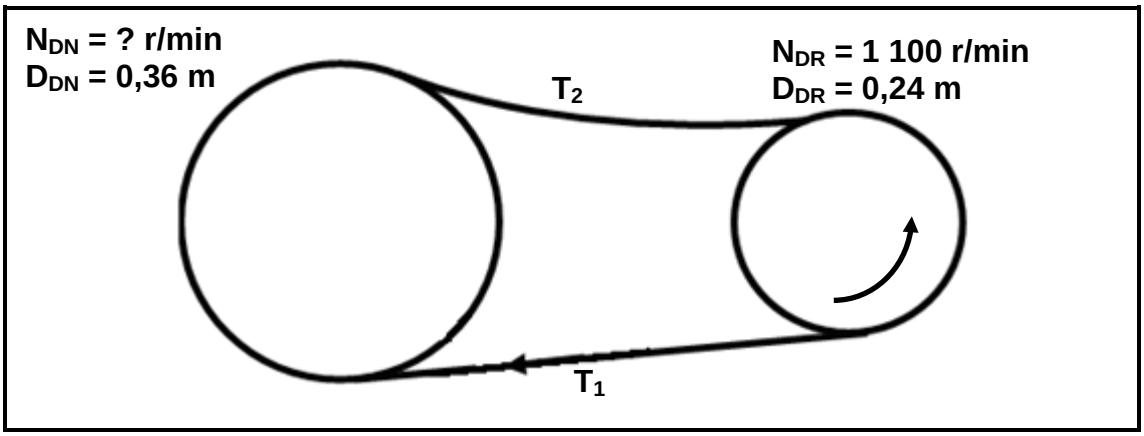

FIGURE 9.2

Determine by means of calculations:

9.2.1 The rotation frequency of the driven pulley in r/min (2)

9.2.2 The power transmitted (2)

9.2.3 The belt speed of the system in metres per second (2)

9.3 A hydraulic system is being used to lift a machine part into position. The specifications of the system are diagrammatically represented in FIGURE 9.3.

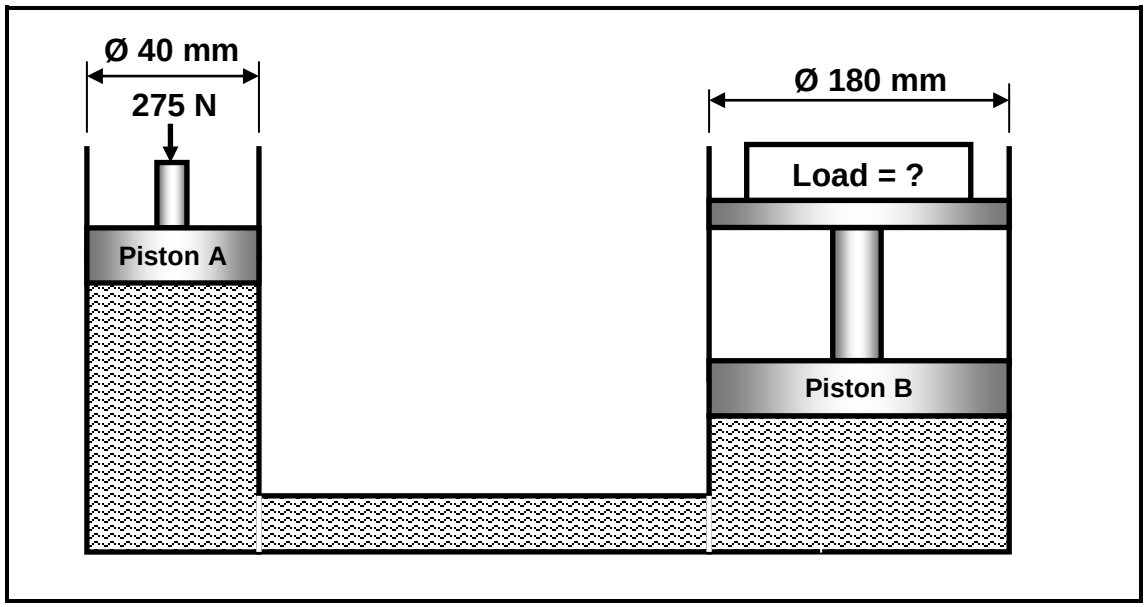

FIGURE 9.3

Determine by means of calculations:

9.3.1 The fluid pressure in the hydraulic system when in equilibrium (3)

9.3.2 The load that can be lifted by piston B when a force of 275 N is applied to piston A (4)

9.4 What do the following abbreviations stand for?

9.4.1 ABS (1)

9.4.2 ECU (1)

9.5 What is *traction control*? (2)

9.6 Explain the operation of the central locking system of motor vehicle doors. (3)
[25]

QUESTION 10: TURBINES

10.1 FIGURE 10.1 shows a water turbine driving a generator. Answer the questions that follow.

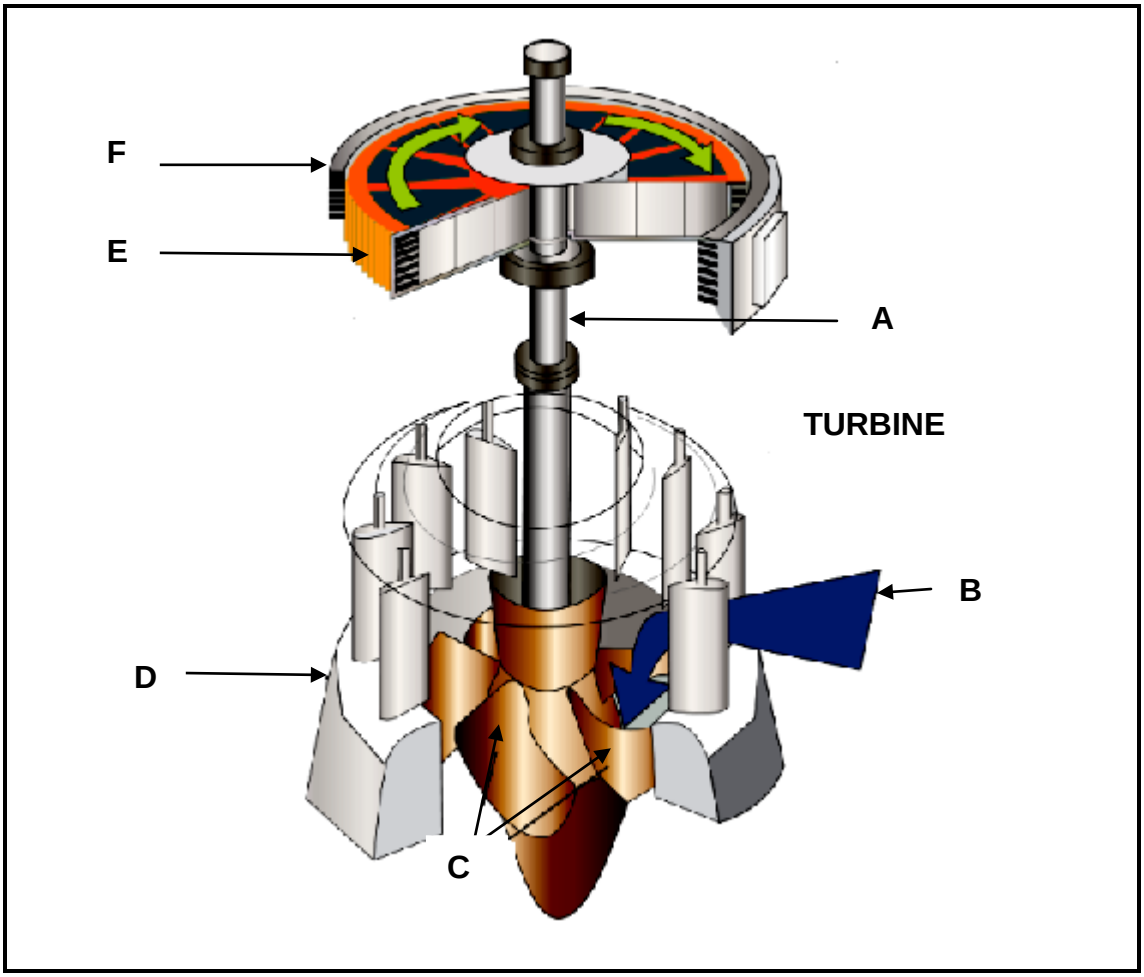

FIGURE 10.1

10.1.1 Write down the letters A–F in your ANSWER BOOK and then the correct labels for the figure next to the corresponding letters. (6)

10.1.2 Explain the operation of the water turbine. (3)

10.2 Many modern motor vehicles make use of superchargers. Answer the questions below.

10.2.1 State TWO advantages of a supercharger. (2)

10.2.2 State ONE disadvantage of a supercharger. (1)

10.3 State TWO advantages of a gas turbine as used in a jet plane. (2)

10.4 A large number of trucks make use of turbochargers to enhance their performance. FIGURE 10.2 shows a turbocharger arrangement.

Write down the letters A–F in your ANSWER BOOK and then the correct labels for the figure next to the corresponding letters.

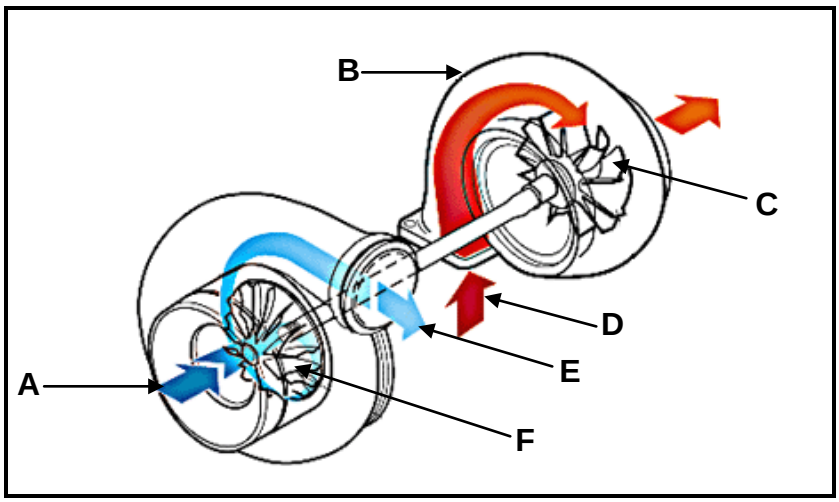

FIGURE 10.2

(6)
[20]

TOTAL: 200

FORMULA SHEET

1. BELT DRIVES

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

1.2 $Belt\ speed = \frac{\pi(D + t) \times N}{60}$ $(t = belt\ thickness)$

1.3 $Belt\ mass = area \times length \times density$ $(A = thickness \times width)$

1.4 $Speed\ ratio = \frac{diameter\ of\ driven\ pulley}{diameter\ of\ driver\ pulley}$

1.5 $Belt\ length(flat) = \lfloor (D + d) \times 1{,}57 \rfloor + (2 \times centre\ distance)$

1.6 $Open\text{-}belt\ length = \frac{\pi(D + d)}{2} + \frac{(D - d)^2}{4c} + 2c$

1.7 $Crossed\text{-}belt\ length = \frac{\pi(D + d)}{2} + \frac{(D + d)^2}{4c} + 2c$

1.8 $Power(P) = \frac{2\pi NT}{60}$

1.9 $Ratio\ of\ tight\ side\ to\ slack\ side = \frac{T_1}{T_2}$

1.10 $Power(P) = \frac{(T_1 - T_2)\pi DN}{60}$ where T_1 = force in the tight side

1.11 $Width = \frac{T_1}{permissible\ tensile\ force}$

2. STRESS AND STRAIN

2.1 $Stress = \frac{force}{area}$ or $(\sigma = \frac{F}{A})$

2.2 $Strain(\varepsilon) = \frac{change\ in\ length\ (\Delta L)}{original\ length\ (L)}$

2.3 $Young's\ modulus(E) = \frac{stress}{strain}$ or $(\frac{\sigma}{\varepsilon})$

3. HYDRAULICS

3.1 $Pressure\ (P) = \frac{Force\ (F)}{Area\ (A)}$

3.2 *Volume = cross-sectional area × stroke length (l or s)*

3.3 *Work done = force × distance*

4. GEAR DRIVES

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

4.2 $Gear\ ratio = \frac{Number\ of\ teeth\ on\ driven\ gear}{Number\ of\ teeth\ on\ driving\ gear}$

4.3 *Torque = force × radius*

4.4 *Torque transmitted = gear ratio × input torque*

4.5 $Module\ (m) = \frac{Pitch\text{-}circle\ diameter\ (PCD)}{Number\ of\ teeth\ (T)}$

4.6 $Pitch\text{-}circle\ diameter\ (PCD) = \frac{circular\ pitch\ (CP) \times number\ of\ teeth\ (T)}{\pi}$

4.7 *Outside diameter (OD) = PCD + 2 module*

4.8 *Addendum (a) = module (m)*

4.9 *Dedendum (b) = 1,157 m* *or* *Dedendum (b) = 1,25 m*

4.10 *Cutting depth (h) = 2,157 m* *or* *Cutting depth (h) = 2,25 m*

4.11 *Clearance (c) = 0,157 m* *or* *Clearance (c) = 0,25 m*

4.12 *Circular pitch (CP) = m × π*

5. PULLEY DRIVES

5.1 $N_1D_1 = N_2D_2$

5.2 $Power\ (P) = \frac{2\pi N T}{60}$

5.3 $Velocity\ ratio = \frac{diameter\ of\ driven\ pulley}{diameter\ of\ driver\ pulley}$

5.4 $r/min\ of\ driven\ pulley = \frac{r/min\ of\ driver\ x\ diameter\ of\ driver\ pulley}{diameter\ of\ driven\ pulley}$

6. KEYWAYS

6.1 $Width\ of\ key = \frac{diameter\ of\ shaft}{4}$

6.2 $Thickness\ of\ key = \frac{diameter\ of\ shaft}{6}$

6.3 *Length of key = 1,5 x diameter of shaft*

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

7. CINCINNATI DIVIDING HEAD TABLE FOR MILLING MACHINE

Hole circles											
Side 1	*24*	*25*	*28*	*30*	*34*	*37*	*38*	*39*	*41*	*42*	*43*
Side 2	*46*	*47*	*49*	*51*	*53*	*54*	*57*	*58*	*59*	*62*	*66*

Standard change gears										
24 x 2	*28*	*32*	*40*	*44*	*48*	*56*	*64*	*72*	*86*	*100*

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