

**NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**MECHANICAL TECHNOLOGY FEBRUARY/MARCH 2015**

**MEMORANDUM**

**MARKS: 200**

**This memorandum consists of 18 pages.**

**QUESTION 1: MULTIPLE-CHOICE QUESTIONS**

1.1 B  (1)

1.2 D  (1)

1.3 C  (1)

1.4 D  (1)

1.5 A  (1)

1.6 B (1)

1.7 C  (1)

1.8 B  (1)

1.9 A  (1)

1.10 D  (1)

1.11 C  (1)

1.12 B (1)

1.13 B  (1)

1.14 D (1)

1.15 A  (1)

1.16 B  (1)

1.17 D  (1)

1.18 D  (1)

1.19 B (1)

1.20 C  (1)

**[20]**

**QUESTION 2: SAFETY**

|  |  |  |
| --- | --- | --- |
| 2.1 | **Surface Grinder:**  • Make sure the sparks are of no danger to co-workers.   • Do not force the grinding wheel onto the material.   • Bring the grinding wheel slowly into contact with the material.  | (3) |
| 2.2 | **Pressure Gauge:** |  |
|  | • To make sure there is no leakages.  |  |
|  | • To make sure that the readings are accurate.  | (2) |
| 2.3 | **Spot Welding:**  To prevent the tips from overheating during operation.  | (1) |
| 2.4 | **Cylinder Leakage test::** |  |
|  | 2.4.1 **Stroke:**  The beginning of compression stroke  | (1) |
|  | 2.4.2 **Piston:**  Bottom dead centre  | (1) |
|  | 2.4.3 **Valves:**  Both valves are closed  | (1) |
| 2.5 | **Bearing Puller:**  Perpendicular/90° to the bearing.  | (1) |
|  |  | **[10]** |

**QUESTION 3: TOOLS AND EQUIPMENT**

|  |  |  |
| --- | --- | --- |
| 3.1 | **Volt and ammeter:** |  |
|  | • Voltmeter: connected in parallel to a circuit.  |
|  | • Ammeter: connected in series to a circuit.   **OR** |
|  | • Credit should be given to the learner for the drawing illustrating the correct answer. | (2) |

3.2 **Beam bending and cylinder leakage tests:**

3.2.1 A beam bending test is to investigate the **deflection**  of

beams.  (2)

3.2.2 A cylinder leakage tester is to check whether **gasses leak** 

from the **cylinders**.  (2)

3.3 **Compression Test:**

The rings are worn out.  (2)

3.4 **Compression tester:**

A – Spark plug adaptor 

B – Pressure gauge 

C – Pressure release valve 

D – Rubber pipe  (4)

**[12]**

**QUESTION 4: MATERIALS**

4.1 **Properties of structures:**

4.1.1 • Soft 

• Ductile 

• Grey or white in colour 

**(Any 2x1)** (2)

4.1.2 • Ductile 

• Hard 

• Strong and tough 

• Resistant to deformation 

**(Any 2x1)** (2)

4.2 Cementite  (2)

4.3 **Classes of steel**

4.3.1 Bolts, nuts, screws and rivets 

**(Any 1x1)** (1)

4.3.2 Surface hardening (case hardened), hardening and tempering 

**(Any 1x1)** (1)

4.3.3 Brittle, poor weldability 

**(Any 1x1)** (1)

4.4 **Definition:**

4.4.1 **Lower Critical point (AC**1 **):**

This is the lowest temperature to which steel must be heated to

be hardened.  (2)

4.4.2 **Critical temperature:**

It is the temperature where a structural change takes place.  (2)

**[13]**

**QUESTION 5: TERMINOLOGY**

5.1 **V-Screw thread cutting :**

• Set up the work-piece in the lathe and turn the part to be threaded to the major diameter of the thread. 

• Set the compound slide 30° to the right and set the tool up accurately in the post 

• Set the quick-change gearbox for 1,5 mm pitch 

• Start the lathe and set the cutting tool so that it just touches the work- piece. Set graduated dials to zero (cross feed and compound slide) 

• Move cutting tool a short distance off end of work-piece and feed compound slide say 0,06 mm inwards. 

• With lathe turning, engage half nuts at the correct line on the chasing dial, putting the first cut in progress 

• Withdraw the cutting tool quickly at the end of the cut and disengage the half-nut lever. Return the carriage to the starting point of the thread. 

• Stop the centre lathe and check with thread gauge to see if thread pitch is correct. 

• Repeat with successive cuts until thread is complete. (Remember to bring cross-feed collar back to zero for each cut). 

• Each successive cut is set by means of the compound slide. 

• Check thread with ring gauge for correct fit.  (11)

5.2 **Cutting depth:**

Cutting depth = 0,866 x P 

= 0,866 x 2,5 

= 2,17 mm 

(3)

5.3 **Indexing:**

Indexing = 40 

n

= 40

82

= 20 

41

No full turns. 20 holes on a 41 hole circle 

(3)

5.4 **Key calculations:**

5.4.1 **Key length:**

Length

Diameter

Diameter

Diameter

= 1.5 × Diameter 

= L

1.5 

= 102

1.5

= 68 mm 

(3)

5.4.2 **Key width:**

Width

Width

= D 

4 

= 68

4

= 17 mm 

(3)

5.4.3 **Key thickness:**

Thickness = D 

6

= 68 

6

Thickness =11.33 mm 

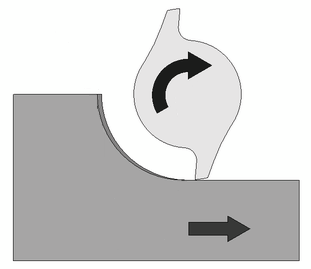
(3)

5.5 **Milling operations:**

**Up-cut milling:**



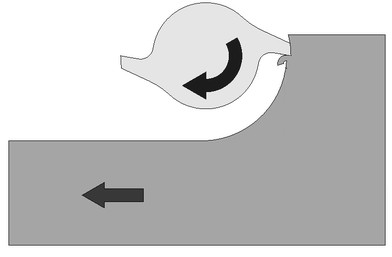




(2)

**Down-cut milling:**







(2)

**[30]**

**QUESTION 6: JOINING METHODS**

6.1 **Welding Machine:**

6.1.1 MIGS/MAGS welding machine  (1)

(7)

6.2 **Operating principles of an X-ray testing equipment:**

|  |  |  |
| --- | --- | --- |
| 6.1.2 | A. | Welding pistol/gun  |
|  | B. | Switch  |
|  | C. | Regulator or Gas flow meter  |
|  | D. | Gas cylinder  |
|  | E. | MIGS/MAGS welding machine  |
|  | F. | Earth cable  |
|  | G. | Welding pistol conduit/welding hose  |

• The X-ray source is placed in front of the object being tested. 

• The source is activated for a brief moment and the X-rays penetrate the test piece. 

• As the X-rays pass through areas of lower density, it will be exposed lighter on the film, which indicates the welding defects. 

• A photographic film with details of defects is provided, which can be

studied.  (6)

6.3 **Advantages of metal-arc shielded welding (MIGS/MAGS):**

• Can weld in any position 

• Less operator skills are required 

• Long welds can be made without stops and starts 

• Minimal post welding cleaning is required 

**(Any 3x1)** (3)

6.4 **Bend test:**

• To measure ductility of the weld deposit and the heat affected area

adjacent to the weld.  (2)

6.5 **Welding defects:**

6.5.1 **Incomplete penetration:**

• Welding speed too high 

• Joint design faulty 

• Arc is to long 

• Current too low 

**(Any 2x1)** (2)

6.5.2 **Welding craters:**

• Current too high 

• Incorrect welding technique 

• Electrode too thin 

**(Any 2x1)** (2)

6.6 **Welding techniques:**

• Rate of electrode burning and progress of the weld 

• The angle of the electrode 

• The distance between the parent metal and the electrode. (Arc length) 

**(Any 2x1)** (2)

**[25]**

**QUESTION 7: FORCES**

7.1 **Equilibrant:**

**210 N**

**210sin25°**



**210cos25°**

**250cos45°** 

**250sin45°**

**250 N**

**25° 45°**

**360 N**

**150 N**

∑ HC = 360 + 250cos45° − 210cos25° 

= 346,45 N 

∑ VC = 250sin45° + 210sin25° − 150 

= 115,53 N 

**OR**

|  |  |  |  |
| --- | --- | --- | --- |
| **HORIZONTAL COMPONENT** | **MAGNITUDES** | **VERTICAL COMPONENT** | **MAGNITUDES** |
| -210 cos25 0  | -190,32N | 210 sin25 0  | 88,75 N |
| 250 cos45 0  | 176,78N | 250 sin45 0  | 176,78 N |
| 360 | 360 N | -150 | -150 N |
| **TOTAL** | **346,45 N**  | **TOTAL** | **115,53 N** |

**HC = 346,45 N** 





**E** 

**VC = 115,53 N**

E2 = HC2 + VC2 

E = 346,452 + 115,532 



E = 365,21 N

Tan

θ

= VC

HC 



= 115,53

346,45

=18,440 

θ

E = 365,21 N at 18,440 south from west



(15)

7.2 **Stress and Strain:**

**Stress:**

A = L2 

A = 0,12

A = 0,01 m2 

= F 

σ

A

80 × 103

=

σ

0,01 

= 8 × 106 Pa

σ σ



= 8 MPa

(5)

7.3 **Strain** is **directly proportional**  to the **stress**  that causes it, provided

the limit of **elasticity** is **not exceeded**. (3)

7.4 **Moments:**

**50 N/m**



UDL

|  |  |
| --- | --- |
|  |  |
|  |
|  |  |

**400 N 600 N**

**1,5 m 5 m**

**2 m 4,5 m**

**A B**

Calculate A

Take moments about 'B'

*A* × *11,5* = (*600* × *4,5*) + (*400* × *6,5*) + (*325* × *9,75*) 

= *2700* + *2600* + *3168,75*

= *8468,75 N* 

*A* =  *8468,75*

*11,5*

*A* = *736,41 N* 

Calculate B

Take moments about “A”

*B* × *11,5* = (*325* × *1,75*) + (*400* × *5*)+ (*600* ×*7* ) 

= *568,75* + *2000* + *4200*

= *6768,75 N* 

*B* =  *6768,75* 

*11,5*

*B* = *588,59 N*

(7)

**[30]**

**QUESTION 8: MAINTENANCE**

8.1 **Advantages of cutting fluid:**

• The workpiece and cutting tool are kept cool. 

• The life of the cutting tool is prolonged. 

• A better finish is imparted to the workpiece. 

• Cuttings are washed away. 

• The worker is protected from very fine metal chips and dust. 

• It prevents corrosion. 

• Productivity is increased because the cutting process is faster. 

|  |  |  |
| --- | --- | --- |
|  | **(Any 2x1)** | (2) |
| 8.2 | Preventive maintenance is maintenance of equipment and systems before faults occur. | (1) |
| 8.3 | **Chain drive:** |  |

8.3.1 **Chain drive preferable to belt drive:**

• It is much stronger 

• It has a much longer service life 

• It provides positive drive. (No slip) 

**(Any 2x1)** (2)

8.3.2 **Stretched chain:**

• The chain loses its strength/tension. 

• It generates more friction. 

• It causes the chain to vibrate. 

• It causes excessive noise. 

• The chain can break. 

• The chain can easily slip from its sprocket. 

**(Any 2x1)** (2)

8.3.2 **Chain Replacement:**

• Align crankshaft and camshaft pulleys before removing the timing chain.

|  |  |
| --- | --- |
| • Disconnect the link plate.  |  |
| • Remove the chain from the sprockets.  |
| • Select the correct length and size replacement chain.  |
| • Fit the new chain.   • Insert the link plate and tension the chain.  | (6) |

8.4 Engine oil must have a high flash point to prevent the vapour to ignite.  (2)

**[15]**

**QUESTION 9: SYSTEM AND CONTROLS**

9.1 **Gear drives:**

9.1.1 **Number of teeth on idler gear:**

TB × NB = NA × TA 



= T × N

A A

T

NB

B



T = 50 × 660

B 1000

TB = 33 teeth 

(3)

9.1.2 **Rotation frequency of the driven gear:**

NC ×TC = NA × TA 

N = NA × TA

C

TC



N = 660 × 50

C 60

N = 550 rpm

C 60

NC = 9,17 r/s 

(3)

9.2 **Belt Drives:**

9.2.1 **Rotation frequency of the driven pulley:**

NDN × (DDN + t) = NDR × (DDR + t) 

= NDR × (DDR + t )

NDN

(DDN

+ t)

NDN =

1640 × (175 + 12) 

(80 + 12)

NDN

= 3333,48 rpm

60



NDN = 55,56 r/s

(3)

9.2.2 **Belt speed:**

v =

π

v =

π

(D + t)N

60 

(0,175 + 0,012)× 1640 

60

v = 16,06 m/s 

(3)

9.3 **Hydraulics:**

9.3.1 **Fluid pressure:**

2

π

A A = ~~D~~

π

4

(0,038)2

A A =

4

A = 1,13 ×10−3 

A

p = FA 

A A

p = 240

1,13 ×10−3

p = 211618,76 Pa 

9.3.2 **Force exerted by piston B:**

*πD 2* 

(3)

*AB* =

*AB* =

*4*

*π* (*0,15* )*2*

*4*

*AB* = *0,017671458 m2* 

*F P* =

*B*

*AB* 

*FB* = *P* × *A*

*FB* = (*211618,76* )× (*0,017671458* )

*FB* = *3739,61 N* 

(4)

9.4 **Purpose of vehicle engine management system:**

**The vehicle engine management system controls the...**

• Engine fuel system 

• Ignition system 

• Exhaust emission 

• Cooling system 

• Battery charging system 

**(Any 4x1)** (4)

|  |  |  |
| --- | --- | --- |
| 9.5 | **Purpose of anti-lock brake system:** |  |
|  | ABS relieves hydraulic pressure on wheels which are about to skid.   action reduces the braking effort that would have caused a skid.   **OR** | This |

The purpose is to provide safer vehicle handling  under difficult

conditions.  (2)

**[25]**

**QUESTION 10: TURBINES**

10.1 **Water turbine:**

• Water turbines do not emit carbon. 

• No water is destroyed in the process of creating electricity. 

• Water turbines are more reliable. 

• Water turbines continue to turn on cloudy and windless days unlike solar and wind operated generators. 

• Environmental friendly and no pollution. 

**(Any 2x1)** (2)

|  |  |  |
| --- | --- | --- |
| 10.2 | **Water turbine definitions:**  10.2.1 Specific speed of a water turbine is the speed at which the |  |
|  | turbine turns for a particular discharge with the unit head, and  thereby is able to produce unit power.  | (2) |
|  | 10.2.2 Free load/runaway speed of a water turbine is its speed at full flow and with no shaft load.  | (2) |
| 10.3 | A steam turbine is a mechanical device that extracts thermal energy from pressurised steam and converts it into useful mechanical work. | (2) |
| 10.4 | **Classification of steam turbine:** |  |
|  | • Condensing turbines  |  |
|  | • Non-condensing turbines  |  |
|  | • Reheat turbines  |  |
|  | • Extraction turbines  |  |
|  | • Induction turbines   **(Any 3x1)** | (3) |
| 10.5 | **Gas turbine for naval vessels:**  It is valued for their high power to weight ratio which has quick acceleration as result.  | (2) |
| 10.6 | **Turbo boost:**  Turbo boost refers to the increase in manifold pressure that is generated by turbocharger in the intake path or specifically intake manifold that exceeds atmospheric pressure | (2) |

10.7 **Operation of twin-screw supercharger:**

• A twin screw supercharger operates by pulling air through a pair of meshing lobes that resemble set of worm gears.

• The air inside a twin screw supercharger is trapped in pockets created by the rotor blades.

• A twin screw supercharger compresses the air inside rotor housing.

• Reason is the rotors have a conical taper which means the air pockets decrease in size as air moves from the fill side to the discharge side.

• As the air pockets shrink, the air is squeezed into a smaller space and

increases the pressure. (5)

**[20]**

**GRAND TOTAL: 200**