GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

REMOTE LEARNING ACTIVITY BOOK

(RELAB)

SUBJECT: FITTING & MACHINING

GRADE: 11

TEACHER GUIDE

(Expected Answers)

GGT2030
GROWING GAUTENG TOGETHER

INTRODUCTION AND PURPOSE OF THE RELAB

The Covid 19 pandemic has caused serious impact to schooling resulting in major learning loss and instructional time. This scenario has resulted in school implementing rotational timetables-where learners attend school on alternate days or weeks. The Remote Learning Activity Book was conceptualized to engage learners in constructive learning on days they are at home. Hence the RELAB was developed as a strategy to enhance remote learning.

The RELAB is underpinned by the following Legislative demands:

a) Responding to GDE Strategic goal 2 promoting quality education across all classrooms and schools
b) **DBE Circular S13 of 2020** the requires the GDE to support the implementation of the Recovery Annual Teaching Plan (RATP)
c) **GDE Circular 11 of 2020** requiring districts to issue Learning Activity Packs to support schools for lockdown learning. Understanding learning constraints at home as majority of learners do not have access to devices or data to use for online learning. Many households are depending on schools to provide them with learning resources packs

RELAB is designed as workbook with activities based on the Revised Annual Teaching Plan. The exercises are pitched at a standard to expose learners at Grade 10 & 11 to content at different cognitive levels. The NSC diagnostic reports in different subjects have revealed that learners fail to analyse questions and as a result fail to respond accordingly.

The RELAB is intended to ensure that learners work on exercises that consolidate and reinforce topics taught while at school. These exercises are be completed at home and would receive feedback as groups or individually when at school. It is therefore of paramount importance that teachers assess the work with learners in class, as a way of providing constructive feedback. Teacher are also required to diagnose learner responses, remediate where necessary and plan further intervention.

Educators are encouraged to create whatsapp groups to remind learners on what is expected of them in a particular week/ day(s). Effective utiisation of the RELAB activity book would further ensure that all topics in the RATP are covered simultaneously. Feedback from learners at home will confirm usage of the RELAB material and assist to prepare learners for formal assessments.

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EXPECTED ANSWERS

SAFETY (GENERIC)

1.1 **Safety precautions when working on the milling machine:**

- Make sure that all guards are in place.
- Do not use a machine or come close to its moving parts while wearing loose clothing.
- Keep any cleaning material such as waste and rags away from rotating parts.
- Check that there is no oil or grease on the floor around the machine.
- Do not leave spanners or keys on rotary parts. Always disconnect, remove or stand clear of handwheels, levers or chuck keys before setting your machine or feeds in motion.
- Never apply a spanner to revolving work.
- Always clamp workpieces and holding devices safely and firmly. A loose fit, especially of spanners and keys, may cause slipping and result in injury.
- Do not use your hands to remove cuttings while a machine is in motion. Use a wire hook or a brush once the machine has stopped.
- Never adjust the cutting tool while a machine is running.
- Resist the habit of leaning on machinery. This dangerous, 'automatic' practice often results in serious injury.
- Do not attempt to stop a machine by placing your hand on the chuck while the machine is slowing down.
- Pay attention to cutting-fluid control before switching on machine.

1.2 Any relevant answer related to a dangerous situation in the workshop egg. Wet floors, broken machines or not enough ventilation.

1.3 **Safety measures for bench grinder wheel:**

- Every grinding wheel should have a guard which can withstand the force of a rupturing wheel.
- Bench grinders must have a transparent shield to protect the operator's eyes.
- Each machine must carry a notice prohibiting persons from performing, inspecting or observing grinding work without wearing suitable protection for the eyes.

1.4 Any relevant answer that shows understanding that the work must be stopped and that you should get help. AND A REASON.

1.5.1 Guillotine

1.5.2 A safety guard that prevents the operator from putting his/her hands near an opening/blade. ALSO, a safety measure that prevents any part of the operator's body to come close to the machine while you're working.

1.6 **Angle grinder:**

• The safety guard must be in place before starting.
• Protective shields must be placed around the object being grinded to protect the people around.
• Use the correct grinding disc for the job.
• Make sure that there are no cracks on the disc before you start.
• Protective clothing and eye protection are essential.

1.7 **Welding helmet:**

• To protect your face against sparks
• To protect your face against UV-rays
• To protect your eyes against UV-rays
• To protect your face against heat

1.8 **Portable drill machine:**

- Do not leave the chuck key in the chuck.
- Clamp the work piece securely to the table, do not hold by hand.
- Clamp the drill bit securely in the chuck.
- Never try to stop the work piece by hand if it slips from the clamp.
- Never try to stop the chuck by hand.
- Do not force drilling.
- Use the correct speed and bit for the job.
- Do not use loose clothing.
- Always wear goggles to protect your eyes

1.9 Ensure that you switch it off.

1.10 **Horizontal band saw:**

- See that all safety guards are in place
- See that there is no grease, oil and obstacles around the machine
- See that the correct blade for the job is installed
- Make sure that work piece is properly clamped
- See that the blade speed is set correctly

1.11 Clamp the small work piece securely and firmly so it does not slip while drilling.

1.12 **Hydraulic press:**

- The predetermined pressure of the hydraulic press must not be exceeded.
- Ensure the pressure gauge is in a good working order.
- Platform in which the work piece rest must be rigid and square with the cylinder of the press.
- Prescribed equipment must be used.
- Check that securing pins for the platform are fitted properly.
- Check hydraulic pipes for leaks.
- Check for oil on the floor.

1.13 **Gas welding equipment:**

- Safety goggles with dark lenses
- Leather apron
- Safety boots
- Use leather gloves
- Overall

1.14 **Flint lighter:**

- Cigarette lighter is explosive AND
- Match burns continuously without stopping

1.15 **Surgical gloves:**

- To prevent infection
- To prevent the transmission of blood related diseases, like HIV/Aids

TERMINOLOGY (SPECIFIC)

2.1 ‘Chalk Method’:

Use a piece of chalk to mark the 'high spot' on the workpiece. Hold the chalk steady by holding it against the tool post. Gradually move it forward until it touches the material. The chalk mark will indicate the 'high spot'.

Release the jaw opposite the chalk mark and then tighten the jaw on the chalk mark side. If the 'high spot' is between the jaws, release the two jaws on the opposite side and tighten the other two jaws. Continue this process until the workpiece runs true.

2.2 Mandrels:

- The workpiece can be removed or mounted easily.
- No setting up using a specialised tool, like a dial test indicator or surface. gauge, is needed when you mount the workpiece.
- The external measurements are true to the internal measurements.
- It makes the production of large quantities of similar work easier.
- The workpiece set-up is true, quick and very simple.
- Mandrels can be changed easily to fit new workpieces.

2.3 Taper calculation:

$$\tan\frac{\theta}{2} = \frac{D-d}{2L}$$

$$\tan\frac{\theta}{2} = \frac{60-50}{2(120)}$$

$$\tan\frac{\theta}{2} = 2{,}4°$$

2.4.1 **Helix angle:**

$$Lead = number\ of\ starts\ \times Pitch$$
$$Lead = 3 \times 8mm$$
$$Lead = 24mm$$

$$Pitch\ diameter = Outside\ diameter - \frac{1}{2}P$$
$$Pitch\ diameter = 44 - \frac{1}{2}(8)$$
$$Pitch\ diameter = 40\ mm$$

$$\tan\theta = \frac{Lead}{\pi \times Pitch\ diameter}$$
$$\tan\theta = \frac{24mm}{\pi \times 40mm}$$
$$\tan\theta = 10{,}81°$$

2.4.2 **Following angle:**

$$Following\ angle = 90° + (helix\ angle - clearance\ angle)$$
$$Following\ angle = 90° + (9{,}8° - 3°)$$
$$Following\ angle = 96{,}8$$

2.4.3 **Leading angle:**

$$Leading\ angle = 90° - (helix\ angle + clearance\ angle)$$
$$Leading\ angle = 90° - (9{,}8° + 3°)$$
$$Leading\ angle = 77{,}2°$$

2.5.1 **Four-jaw chuck:** To clamp an awkwardly-shaped object in a centre lathe.

2.5.2 **Lathe steadies:** To support long or slender shafts in one or more places, in a centre lathe.

2.5.3 **Lathe mandrels:** It is used for the further machining of a work piece between centres after it has been bored or reamed while held in the chuck.

2.6

$$tan\frac{\theta}{2} = \frac{D-d}{2l} \checkmark$$

$$tan\frac{\theta}{2} = \frac{78-62}{2(105)}$$

$$\frac{\theta}{2} = 4{,}36°$$

2.7.1 **Helix angle:**

$$Lead = number\ of\ starts \times Pitch$$

$$Lead = 3 \times 7\ mm$$

$$Lead = 21\ mm$$

$$\tan\theta = \frac{Lead}{\pi \times Pitch\ diameter}$$

$$\tan\theta = \frac{21mm}{\pi \times 90mm}$$

$$\tan\theta = 4{,}25°$$

2.7.2 **Following angle:**

$$Following\ angle = 90° + (helix\ angle - clearance\ angle)$$

$$Following\ angle = 90° + (4{,}25° - 3°)$$

$$Following\ angle = 91{,}25°$$

2.7.3 **Leading angle:**

$$Leading\ angle = 90° - (helix\ angle + clearance\ angle)$$

$$Leading\ angle = 90° - (4{,}25° + 3°)$$

$$Leading\ angle = 82{,}75°$$

2.8.1 **The width:**

$$Width\ of\ key = \frac{Diameter\ of\ shaft}{4} \checkmark$$
$$= \frac{60}{4}$$
$$= 15\ \text{mm} \checkmark$$

2.8.2 **The thickness:**

$$Thickness\ of\ key = \frac{Diameter\ of\ shaft}{6} \checkmark$$
$$= \frac{60}{6}$$
$$= 10\ \text{mm} \checkmark$$

2.8.3 **The length:**

$$Length\ of\ key = 1{,}5 \times diameter\ of\ shaft \checkmark$$
$$= 1{,}5 \times 60$$
$$= 90\ \text{mm} \checkmark$$

2.9.1 Side and face mill.

2.9.2 T-slot mill.

TOOLS (GENERIC)

3.1 **a.** Pitch
b. Root
c. Pitch diameter
d. Thickness of thread
e. Thread angle

3.2 **First Tap:**

- The taper/starting/first tap all refer to the same thing.
- The tap is tapered for about half its length to a reamer point that fits into the hole and helps to give a good start.
- If this tap is taken right through the work piece, a complete thread will be cut.

The intermediate or second tap:

- The intermediate or second tap is used for making a complete thread in a blind hole, or where the taper tap cannot pass right through a workpiece.
- This tap is used after a taper tap and has only a few threads tapering at its end.

Die prop- of boomsnytap:

- The plug or bottoming tap, which has no taper at all, is used to complete the cutting of the thread to the bottom of a blind hole.

3.3 Cutting;
Grinding; and
Polishing

3.4.1 Pedestal drill.

3.4.2 A. Base
B. Column
C. Motor
D. Feed lever
E. Chuck
F. Machine table

3.4.3 To hold the drill.

3.5 **Tap and die set:**
• Tap to cut internal screw threads
• Die to cut external screw threads

3.6 **Saws:**
• Power saw – blade move forward and backward
• Horizontal band saw – blade moves in a circular motion

3.7.1 **Rolling machine –** used to roll sheet metal.

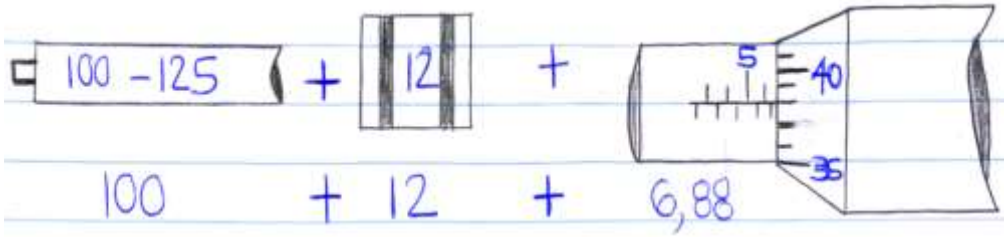
3.7.2 **Press machine –** press fit or remove parts from each other.

TOOLS (SPECIFIC)

4.1
- determine if a workpiece in a centre lathe is running true
- test tapers on a sine bar
- test projects for roundness
- test something for concentricity
- test the limits of sizes
- determine the run-out of a flywheel
- determine if a crankshaft is bent
- determine of two pieces of equipment are the same size
- determine the bearing nip on a bearing shell used on a crankshaft
- determine the end float on a crankshaft
- square a machine vice on a milling machine table.

4.2
- Clean the torque wrench.
- Make sure that the sockets fit properly.
- Store it properly after use
- Don't apply shock loads.

4.3.1



4.4
A. Rotatable bezel and dial
B. Graduated all round in 0,01 mm
C. Plunger movement
D. Removable anvil
E. Plunger
F. Spigot
G. Revolution counter
H. Pointer/hand

4.5.1 Telescopic gauge, because it's easy and quick to use.

4.5.2 **Telescopic gauge care:**

- Do not over-tighten the locking screw.
- Do not force the telescopic plungers into the bore.
- Take care when removing the telescopic gauge after the measurement has been taken.
- Store gauges away safely after use**.**

4.6.1 **Dial indicator**: It is used as precision-measuring tool in setting up of work on machinery, such as centre lathes or milling machines.

4.6.2 **Telescopic gauge:** To provide a quick and accurate method of checking inside measurements.

4.7 **Reasons for using a torque wrench:**

• It prevents bolts or studs from breaking.
• It prevents bolts and nuts from loosening.
• It prevents castings from warping.

4.8 170,11 mm

FORCES (SPECIFIC)

5.1

Horizontal components:	Vertical components:
35 cos 0° = +35,00 N 50 cos 90° = + 0,00 N 25 cos 60° = +12,50 N 47,50 N (x)	35 sin 0° = + 0,00 N 50 sin 90° = +50,00 N 25 sin 60° = - 21,65 N 28,35 N (y)

$R^2 = X^2 + Y^2$
$R^2 = (47{,}50)^2 + (28{,}35)^2$
$R^2 = \sqrt{3059{,}9725}$
$R^2 = 55{,}32\ N$

$\tan\theta = \frac{y}{x}$
$\tan\theta = \frac{28{,}35}{47{,}50}$
$\theta = 30{,}83°$

R = 55,32 N in a direction of 30,83° NE

5.2

Take moments about RL
LOM = ROM
RR x 0,1 m = (750N x 0,0525 m)
RR x 0,1 = 39,375
0,1 = 0,1
RR = 393,75 N

Take moments about RR
ROM = LOM
RL x 0,1 m = (750N x 0,0475 m)
RL x 0,1 = 35,625
0,1 = 0,1
RL = 356,25 N

393,75 N + 356,25 N = 750 N
750 N = 750 N

5.3 BmA = + (356,25 N x 0,0525 m) – (750 N x 0 m)
= 18,70 Nm

5.4 $Area = \left(\frac{\pi D^2}{4}\right) - \left(\frac{\pi d^2}{4}\right)$
$Area = \left(\frac{\pi(0{,}03)^2}{4}\right) - \left(\frac{\pi(0{,}026)^2}{4}\right)$
$Area = 1{,}75929 \times 10^{-4}\ m^2$

$$S = \frac{F}{A}$$
$$S = \frac{30\ \times 10^3}{A}$$
$$S = 170\ 523\ 153{,}3\ Pa$$

5.5

Moments:

Calculate A. Take moments about B.

$$\sum LHM = \sum RHM$$
$$(A\ \times 3{,}2) + (300\ \times\ 1{,}2) = (800\ \times 2{,}4) \quad ✓$$
$$\frac{3{,}2A}{3{,}2} = \frac{1\ 920\ - 360}{3{,}2}$$
$$A = 487{,}5\ N \quad ✓$$

Calculate B. Take moments about A.

$$\sum RHM = \sum LHM$$
$$(B\ \times 3{,}2) + (800\ \times\ 0{,}8) = (300\ \times 4{,}4) \quad ✓$$
$$\frac{3{,}2B}{3{,}2} = \frac{640\ - 1320}{3{,}2}$$
$$B = 612{,}5\ N \quad ✓$$

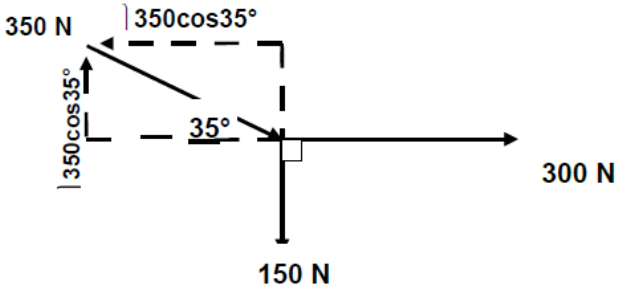
5.6

Stress:

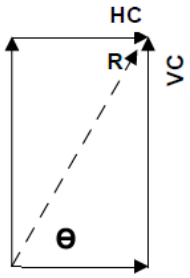
$$A = \frac{\pi(D^2 - d^2)}{4} \quad ✓$$
$$= \frac{\pi(0{,}06^2 - 0{,}054)}{4}$$
$$= 0{,}54\ \times\ 10^{-3} m^2 \quad ✓$$

$$\sigma = \frac{F}{A} \quad ✓$$
$$= \frac{60 \times 10^3}{0{,}54 \times 10^{-3}} \quad ✓$$
$$= 111{,}11\ \times\ 10^6\ Pa$$
$$= 111{,}11\ MPa \quad ✓$$

5.7 **Forces:**



$$HC = 300 - 350\cos 35° \quad \checkmark$$
$$= 300 - 286{,}70$$
$$= 13{,}3\,N \quad \checkmark$$



$$VC = 350\sin 35° - 150 \quad \checkmark$$
$$= 200{,}75 - 150$$
$$= 50{,}75\,N \quad \checkmark$$

$$R^2 = HC^2 + VC^2$$
$$\sqrt{R^2} = \sqrt{13{,}3^2 + 50{,}75^2}$$
$$R = 52{,}46\,N \quad \checkmark$$

$$Tan\theta = \frac{VC}{HC}$$
$$= \frac{50{,}75}{13{,}3}$$
$$\theta = 75{,}31° \quad \checkmark$$

Resultant = 52,46 N 75,31° North from East ✓

MAINTENANCE (SPECIFIC)

6.1 When we try to slide one surface over another, as shown below, it leads to resistance, which prevents (or tends to prevent) movement. The resistance to movement is due to friction. This causes heat and can cause wear and tear of parts, or parts that break.

6.2
- Holding work in a machine or bench vice
- Clamping work to the machine table
- Brakes
- Belts and pulleys
- Clutches
- Drills and reamers

6.3.1 **Static balancing:**

In static balancing, a body or system at rest will stay at rest in any position although it is free to move, i.e., if the body or system is in a position to rotate about an axis, it will not turn or rotate due to the influence of gravity.

6.3.2 **Dynamic balancing:**

In dynamic balancing a body or a system will not exert a centrifugal force upon its fulcrum or point of support when rotating.

6.4 **Trial-and-error method of balancing:**

- Bolt the workpiece to the face plate of the centre lathe.
- Put the centre lathe in neutral and allow the heavy point to rotate to the bottom.
- Bolt a suitable balance mass diametrically opposite the heavy point.
- Balance is obtained by moving the balance mass in and out radially. This is done while the workpiece is being set to run true.

6.5 **Lathes and milling machines:**

- Lack of lubrication
- Overloading
- Balancing

6.6 **Overheating:**

If a machine runs over extended periods with inadequate lubrication the machine will exceed the normal operating temperature which will cause excessive friction and wear.

6.7 **Physical wear on the milling cutter of a milling machine:**

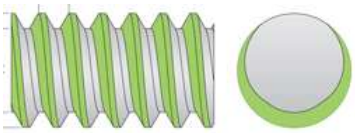
- Cutting fluid should be applied.
- Do not exceed the appropriate cutting depth.
- Do not exceed the appropriate feed.

6.8 **Unbalanced work piece in a lathe:**

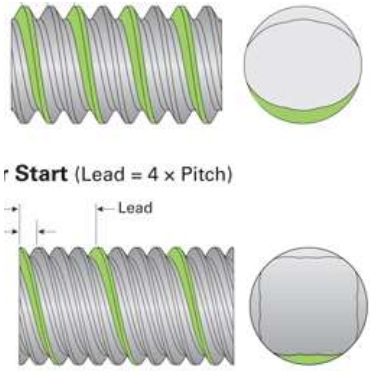
- Vibration
- Inaccurate results
- Risk of work piece coming loose

JOINING METHODS (SPECIFIC)

7.1 Single-start screw thread



Multi-start screw thread



7.2 $Lead = number\ of\ starts \times pitch$

$Lead = 2 \times 4\ mm$

$Lead = 8\ mm$

7.3.1 $Depth = 0{,}613 \times P$

$Depth = 0{,}613 \times 1{,}75\ mm$

$Depth = 1{,}07\ mm$

7.3.2 $Height = 0{,}86603 \times P$

$Height = 0{,}86603 \times 1{,}75\ mm$

$Height = 1{,}51\ mm$

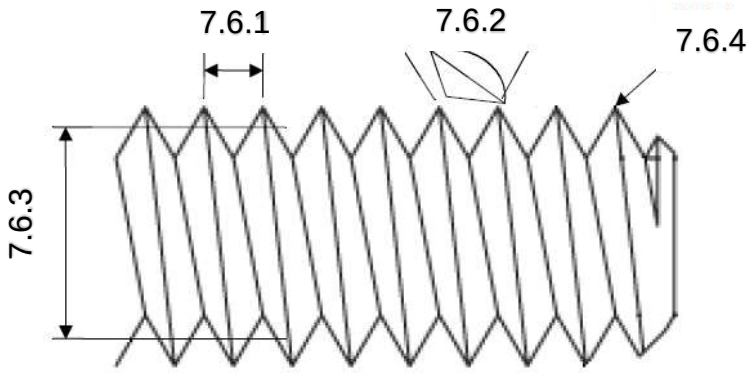
7.4 $Tap\ drill\ size = OD - P$

$Tap\ drill\ size = 8\ mm - 1{,}5\ mm$

$Tap\ drill\ size = 6{,}5\ mm$

7.5 A multi-start thread allows for quicker movement of the nut in the direction required (less turns to move the nut twice as far, in the case of a two start thread. With four starts the nut literally moves four times as far per turn.)

7.6 **Isometric V-screw thread:**



7.6.1 Pitch

7.6.2 Screw thread angle

7.6.3 Effective diameter

7.6.4 Crest

7.7.1 **The depth of the screw thread:**

$H = 0{,}86603\ P$

$= 0{,}86603 \times 2{,}5$ ✓

$= 2{,}165075\ mm$ ✓

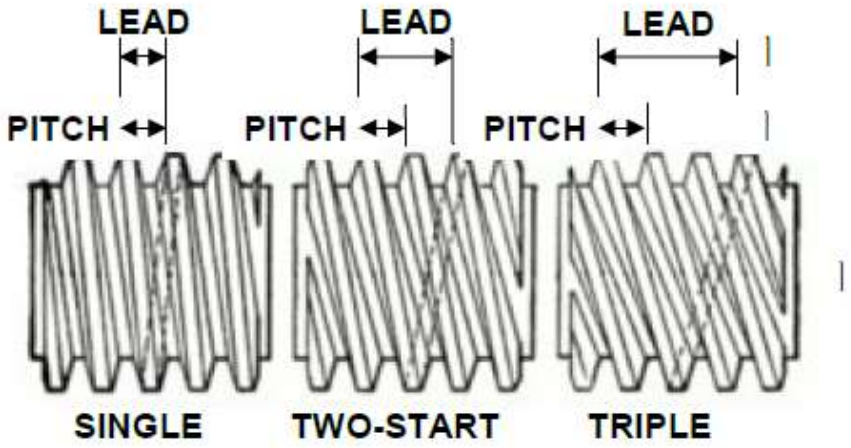
7.7.2 **The effective diameter of the screw thread:**

$Pitch\ diameter\ of\ thread = OD - 2\left(\frac{3H}{8}\right)$

$= 20 - 2\left(\frac{3 \times 2{,}17}{8}\right)$ ✓

$= 18{,}38$ mm ✓

7.8 **Single- and multiple-start screw threads:**



MATERIALS (GENERIC)

8.1.1 **Hardness:** Ability to withstand surface indentation and scratching.

8.1.2 **Elasticity**: Ability of a body to resist a distorting influence or stress and to return to its original size and shape when the stress is removed.

8.1.3 **Malleability:** Ability to deform permanently under compressive forces or hammering without developing defects.

8.1.4 **Toughness:** Ability of a material to absorb shock loads.

8.2 **Any ONE of the following:**

Coke plays a threefold role in the blast furnace:

1 As a fuel to provide heat for the smeltery.

2 As a rich source of carbon monoxide gas, a reducing agent in the conversion of iron oxide to iron.

3 As a non-solid support for the charge in the oven. The porous nature of coke contributes to the free flow of gas through the blast furnace.

8.3 Low carbon steel
Medium carbon steel
High carbon steel

8.4 Metallurgy

8.5.1 Materials added: limestone, warm air.

8.5.2 Product of blast furnace: pig iron

8.6 Waste product: slag

8.7 Carbon

8.8
- Iron ore
- Coke
- Limestone
- Warm air

8.9 Iron ore is the material which iron is made out of.

8.10 **Blast furnace labels:**

A. Iron tap hole
B. Hot air supply from stoves
C. Steel casing
D. Refractory brick lining
E. Hopper or Load
F. Small bel
G. Larger bell
H. Stack
I. Melting zone
J. Slag tap hole

SYSTEMS AND CONTROL (SPECIFIC)

9.1.1 π x D_A X $N_A = \pi$ x D_B x N_B

π x 158 X 20 x 60 = π x 401 x N_B

$N_B = \frac{158\ x\ 1200}{401}$

$N_B = \frac{189600}{401}$

N_B = 472,8 r/min

OR

π x D_A X $N_A = \pi$ x D_B x N_B

$N_B = \frac{\pi \text{ x DA X NA}}{DB}$

$N_B = \frac{158 \text{ X } 20}{401}$

N_B = 7,8 r/sek x 60

N_B = 472,8 r/min

9.2 $\frac{\textbf{Revolution of the final driven gear}}{\textbf{Revolution of the first drive gear}} = \frac{\textbf{Product of the number of teeth on drive gears}}{\textbf{Product of the number of teeth on driven gears}}$

$\frac{ND}{NA} = \frac{TA\ x\ TC}{TB\ x\ TD}$

$\frac{ND}{NA} = \frac{32\ x\ 34}{16\ x\ 12}$

$N_D = \frac{17}{3}$ x 900

N_D = 5100 r/min

OR

1. N_A x T_A = N_B x T_B

900 x 32 = N_D x 16

$N_B = \frac{28800}{16}$

2. $N_C \times T_C = N_D \times T_D$

$\frac{1800\ x\ 34}{12} \times \frac{ND\ x\ 12}{12}$

$N_D = \frac{61200}{12}$

$N_D = 5100$ r/min

9.3 $A = \pi r^2$

$A = \pi(0{,}125)^2$

$A = 0{,}049\ m^2$

F = A x P

F = $\frac{\pi D^2}{4}$ x 4000

F = 0,049 x 4000

F = 196,35 N

9.4.1 Non-return valve.

9.4.2 These valves are mostly used in small, piston-type pumps and in small oil pipelines to provide one-directional oil flow - the fluid cannot be forced back (into the opposite direction of the flow) because of pressure pulses in the hydraulic system.

9.5
- Bourdon-buismeter
- Schrader meter

9.6 **Advantages of a belt drive compared to a gear drive:**

• Power can be transmitted over a longer distance.
• Less noisy.
• Does not need any lubrication.
• Change of direction can be done by twisting the belt, therefore no extra parts are needed.
• Cheaper system.
• Easy to repair.

9.7 **Hydraulics:**

$$A_{suier} = \frac{\pi d^2}{4} \quad \checkmark$$
$$= \frac{\pi(0{,}12)^2}{4} \checkmark$$
$$= 11{,}31 \times 10^{-3}\ m^2 \checkmark$$

$$p = \frac{F}{A} \checkmark$$
$$F = p \times A$$
$$= (1{,}2 \times 10^6) \times (11{,}31 \times 10^{-3})$$
$$= 13\,572\ N$$
$$= 13{,}57\ kN \checkmark$$

9.8.1 **Belt speed:**

$$Belt\ speed = \frac{\pi DN}{60} \checkmark$$
$$= \frac{\pi \times 0{,}23 \times 1440}{60}$$
$$= 17{,}34\ m.s^{-1} \checkmark$$

9.8.2 **Power transmitted:**

$$Power\ (p) = (T_1 - T_2)v \quad \checkmark$$
$$= 165 \times 17{,}34$$
$$= 2861{,}1\ W$$
$$= 2{,}86\ kW \checkmark$$

9.9.1 **Direction of rotation of gear C** = Clockwise

9.9.2 **Number of teeth on gear C:**

$$T_C N_C = T_A N_A \checkmark$$

$$T_C = \frac{T_A \times N_A}{N_C}$$
$$= \frac{102 \times 120}{80}$$
$$= 153\ teeth \checkmark$$

9.10

Gear ratio of the system:

$$Gear\ ratio = \frac{Product\ of\ the\ number\ of\ teeth\ on\ driver\ gears}{Product\ of\ the\ number\ of\ teeth\ on\ the\ driven\ gears} \checkmark$$

$$= \frac{54}{18}$$

$$= 1:3 \checkmark$$

PUMPS (SPECIFIC)

10.1.1

Piston	***Plunger***
Length of piston is shorter than stroke length OR Piston has rings	*Length of plunger is longer than stroke length OR The plunger has a seal bush at the end of the cylinder*

10..2
- Worn external gasket
- Worn internal gasket
- A sieve that is uncovered above the liquid level
- An incorrect foot valve
- Faulty or loose flanges or loops
- A weak or erratic valve bed or spring

10.3
1– inlet
2– eye
3– outlet
4– housing / casing
5– impellers / blades
6– liquid / flow direction

10.4 **Mono pump:**
- Food and drink pump
- Oil pumping
- Slurry pumping
- Sewage sludge pumping
- Viscous chemical pumping

10.5 **Advantages of centrifugal pumps:**

• More compact less floor space.

• Initial cost is relatively low.

• Maintenance costs are low due to rotating motion of the main parts.

• Are quite adaptable.

• Construction of the pump is simple and reliable.

• Works at high speeds can be connected directly to a motor

• Water hammer and shocks do not occur because the pump delivers a regular and continuous stream of fluid.

• Have no moving valves or sensitive parts. The delivery of fluid can be regulated from no flow to full flow without switching off or damaging the pump.

10.6 **Reciprocating pump:**

• An inlet valve also called admission pump

• An outlet valve also called a discharge valve

• A pump or piston

10.7 **Disadvantages of gear pumps:**

• Wear between the gears and the housing reduces the pump pressure.

• When the gears wear the pump tends to be noisy.

10.8.1 Open-vane impeller.

10.8.2 Semi-open or ribbed impeller.

10.8.3 Enclosed or shrouded impeller.

FORMULA SHEET

1. STRESS AND STRAIN

1.1 $Stress = \frac{Force}{Area}\ or\ (\sigma = \frac{F}{A})$

1.2 $Area_{Shaft} = \frac{\pi d^2}{4}$

1.3 $Area_{Pipe} = \frac{\pi(D^2 - d^2)}{4}$

1.4 $Area_{square\ bar} = length \times breadth$

2. KEYS

2.1 $Width\ of\ key = \frac{Diameter\ of\ shaft}{4}$

2.2 $Thickness\ of\ key = \frac{Diameter\ of\ shaft}{6}$

2.3 $Length\ of\ key = 1{,}5 \times Diameter\ of\ shaft$

2.4 Standard taper for taper key: 1 in 100 or 1 : 100

3. SCREW THREAD

3.1 *Lead = number of starts x pitch*

3.2 *Helix angle:* $tan\theta = \frac{lead}{\pi.diameter}$

3.3 *Leading tool angle = 90° – (helix angle + clearance angle)*

3.4 *Following tool angle = 90° + (helix angle – clearance angle)*

3.5 *Depth of thread : D = 0,613 x P*

3.6 *Height of thread: H = 0,88603 x P*

3.7 *Pitch diameter of thread :* $= 0D - 2 \times [\frac{3 \times H}{8}]$

4. TAPER TURNING

4.1 *Compound slide angle: tan* $\frac{\theta}{2} = \frac{D-d}{2L}$

5. GEARS

5.1 N_A x T_A = N_B x T_B

5.2 $\frac{N_{INPUT}}{N_{OUTPUT}} = \frac{\textbf{Product of number of teeth on Driven gears}}{\textbf{Product of number of teeth on Drive gears}}$

6. PULLEYS

6.1 π x D_A X $N_A = \pi$ x D_B x N_B

6.2 Effective tension in belt = $T_{(A)} - T_{(B)}$

6.3 Force transmitted = Force N x distance travelled in m/s

7. HYDRAULICS

7.1 Pressure = $\frac{Force}{Area}$

7.2 Volume = $SL\ x\ A$

7.3 Area = $\frac{\pi d^2}{4}$