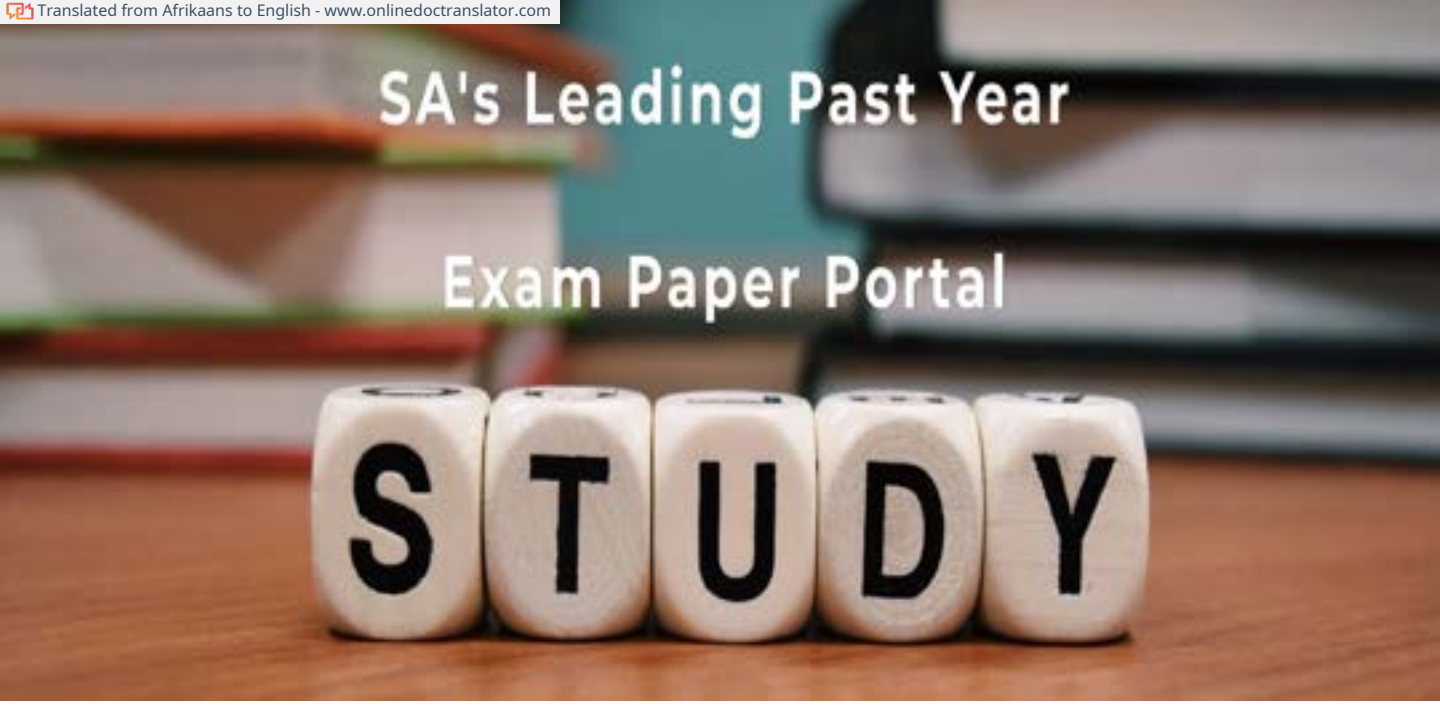
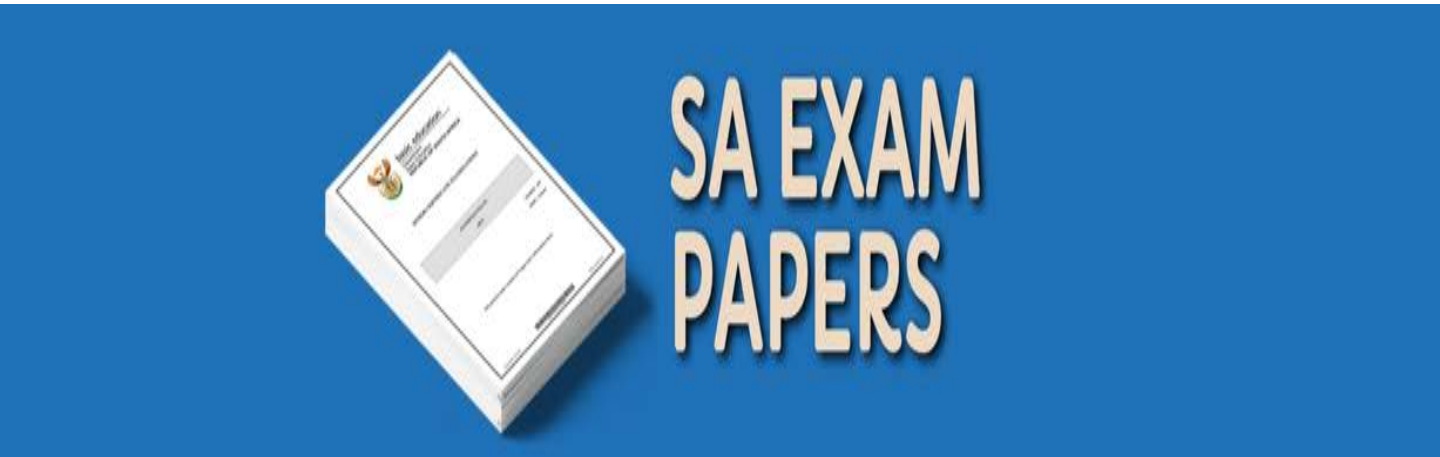




basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

MECHANICAL TECHNOLOGY: FITTING AND MACHINING

NOVEMBER 2022

MARKING GUIDELINES

MARKS: 200

These marking guidelines consist of 23 pages.

QUESTION 1: MULTIPLE CHOICE QUESTIONS (GENERIC)

1.1 B - (1)

1.2 B - (1)

1.3 C - (1)

1.4 C - (1)

1.5 A - (1)

1.6 B - (1)
[6]

QUESTION 2: SECURITY (GENERIC)

2.1 **Essential Functions:**

- Breathing -
- Heart rate / pulse - State
- of consciousness -

(Any 2 x 1) (2)

2.2 **Safety glasses during grinding:**

- To prevent any injuries to the operator's eyes. - To protect
- eyes from sparks and splashes. -
- To prevent blindness due to injuries. -

(Any 1 x 1) (1)

2.3 **Type of screens:**

- Fixed Screen -
- Automatic wiper / pusher - Self-controlled /
- automatic screen - Electronic motion
- sensor / air curtain - Two-handed control
- mechanism -

(Any 2 x 1) (2)

2.4 **Precautions *before* gas welding procedures can be performed:**

- An operator is trained in how to use the equipment safely. - The work
- area is effectively partitioned off. -
- The operator uses personal protective equipment (PBT) *(PPE)*. -
- Ensure fire extinguisher equipment is on hand. -
- Ensure the equipment is in safe working condition. -
- Make sure that the gas equipment is set up correctly.
- - Ensure that the area is well ventilated - Ensure that
- the work area is safe. -

(Any 3 x 1) (3)

2.5 **TWO disadvantages of product layout:**

- Lack of flexibility/adaptability. - Optimal use of
- equipment is not possible. - (2)

[10]

QUESTION 3: MATERIAL (GENERIC)

3.1 **THREE characteristics:**

- toughness -
- Hardness / Resistance to wear -
- Softness -
- shell hardening -
- Stretchability -
- Malleability -
- Elasticity -
- brittleness -
- Strength -

(Any 3 x 1) (3)

3.2 **Heat treatment processes:**

3.2.1 **Tempering:**

- It consists of heating the hardened steel - to a temperature below its critical temperature (color chart). -
- Soak it at this temperature for some time. -
- Quench/cool it quickly in water, brine or oil. - (4)

3.2.2 **Hardening:**

-The steel is heated slightly above the higher critical temperature. -
- The steel is then soaked at this temperature for a period of time. -
- The steel is then quickly quenched in water, brine or oil. - (3)

3.3 **Examples of shell hardening:**

- Bearing housings -
- bearing balls -
- lower needles -
- Crankshafts -
- gears -
- Camshafts -
- Cylinder liners -
- Hammerheads -
- Air Drill Bits -

(Any 2 x 1) (2)

3.4 **Why steel is cooled in still air, away from drafts:** This prevents the sudden cooling of a localized spot - which can cause warping/cracking. - (2)

[14]

QUESTION 4: MULTIPLE CHOICE QUESTIONS (SPECIFIC)

4.1	C -	(1)
4.2	A -	(1)
4.3	B -	(1)
4.4	D -	(1)
4.5	C -	(1)
4.6	A -	(1)
4.7	B -	(1)
4.8	B -	(1)
4.9	C -	(1)
4.10	A -	(1)
4.11	B -	(1)
4.12	A -	(1)
4.13	D -	(1)
4.14	D -	(1)
		[14]

QUESTION 5: TERMINOLOGY (LATHE AND MILLING MACHINE) (SPECIFIC)

5.1 **Advantages of redemption method:**

- Long tapers can be cut. -
- The automatic feed can be used. - Good
- finish is obtained. -

(Any 2 x 1) (2)

5.2 **Large diameter of taper:**

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

D-Tan $\frac{\theta}{2}$-2-l--d

- Tan $\frac{8}{}$--2-290--42 2

-Tan4--580--42

D = 82.56 mm (4)

5.3 **Calculation of parallelspy:**

5.3.1 Width - $\frac{D}{4}$

- $\frac{65}{4}$ -

-16.25 mm- (2)

5.3.2 Thickness - $\frac{D}{6}$

- $\frac{65}{6}$ -

-10.83 mm - (2)

5.3.3 Length - 1.5- diameter of shaft

-1.5-65 -

-97.5 mm - (2)

5.4 **Disadvantages of link milling:**

- The group milling puts more stress on the machine's spindle
- bearings. - Due to more than one cutter being used, the milling machine works harder. -
- There may be more vibration. -
- Poor finish. -

(Any 1 x 1) (1)

5.5 **TWO milling processes:**

The milling of:

- swing -
- spigots -
- Slots -
- Bevel / ridge -
- Other angles -
- Grooves -
- Set devices*(gout)*- T
- connections*(teas)*-
- dovetail slots -
- Surface milling -
- Drilling -
- space work -
- Tapping -
- Climbing Work -
- milling work -

(Any 2 x 1) (2)

5.6 **Calculate X:**

$$x\text{-}\ \frac{\text{Diameter of workpiece-Thickness of cutter}}{2}$$

$$-\ \frac{60\text{-}12}{2}$$

$$-\ \frac{48}{2}$$

-24mm (3)

[18]

QUESTION 6: TERMINOLOGY (INDEXING) (SPECIFIC)

6.1 **Gear calculations:**

6.1.1 **Module:**

$$\text{Module} - \frac{SSD}{T}$$

$$- \frac{165}{110}$$

-1.5

(2)

6.1.2 **Outer diameter:**

BD = SSD +2(m)

= 165 + 2(1.5) - =

168 mm -

OR

BD = m(T + 2)

= 1.5(110 + 2) - =

168 mm -

(2)

6.2 **Dovetail calculations:**

W = 120 + 2(DE)

m = W – [2(AC) + 2(R)]**OR**m = W – 2(AC + R)**OR**m = W – 2(AC) – 2(R)

6.2.1 **Maximum distance from dovetail. (W)**

Calculate DE:

$$\text{Tan} - = \frac{DE}{A.D}$$

DE = tan–A.D

= tan30° - 30

= 17.32mm

OR

$$\text{Tan} - = \frac{A.D}{DE}$$

$$DE = \frac{A.D}{\text{Tan}60_{oh}}$$

$$= \frac{30}{\text{Tan}60_{oh}}$$

=17.32mm

W = 120 + 2(DE) -

= 120 + 2(17.32) - =

120 + 34.64

= 154.64 mm -

(6)

6.2.2 **Distance between rollers. (m)**

Calculate AC:

$\text{Tan}\theta = \frac{B.C}{AC}$

$AC = \frac{B.C}{\text{Tan}\theta}$

$= \frac{11}{\text{Tan}30}$

=19.05mm

$\text{Tan} = \frac{AC}{B.C}$

AC = Tan –B.C

OR

= Tan60oh- 11

=19.05mm

m = W – [(2(AC) + 2(R)] -
= 154.64 – [2(19.05) + 2(11)] - =
154.64 – (38.10 + 22)
= 94.54 mm -

OR

m = W – 2(AC + R) -
= 154.64 – 2(19.05 + 11) - =
154.64 – (38.10 + 22)
= 94.54 mm -

OR

m = W – 2(AC) – 2(R) -
= 154.64 – 2(19.05) – 2(11) - =
154.64 – 38.11 – 22
= 94.54 mm -

(6)

6.3 **Milling of spur gear:**

6.3.1 **Indexing:**

indexing- $\frac{40}{a} - \frac{40}{163}$

$- \frac{40}{A} - \frac{40}{160}$

$- \frac{1}{4} \frac{6}{6}$

$- \frac{6}{24}$

Approximate indexing: 6 holes on a 24-hole circle. -

OR

7 holes on a 28 hole circle. - (3)

6.3.2 **Gears:**

$\frac{Dr}{God} = (A - n) - \frac{40}{A}$

$= (160 - 163) - \frac{40}{160}$

$= -3 - \frac{40}{160}$

$= \frac{-120}{160}$

$= \frac{12}{16} - \frac{2}{2}$ **OR** $\frac{12}{16} - \frac{4}{4}$

$= \frac{24}{32}$ **OR** $\frac{48}{64}$ (5)

6.4 **TWO types of balancing methods:**

- Static balancing (stationary balancing) -
- Dynamic balancing (running balancing) - (2)

6.5 **TWO benefits of correct balancing:**

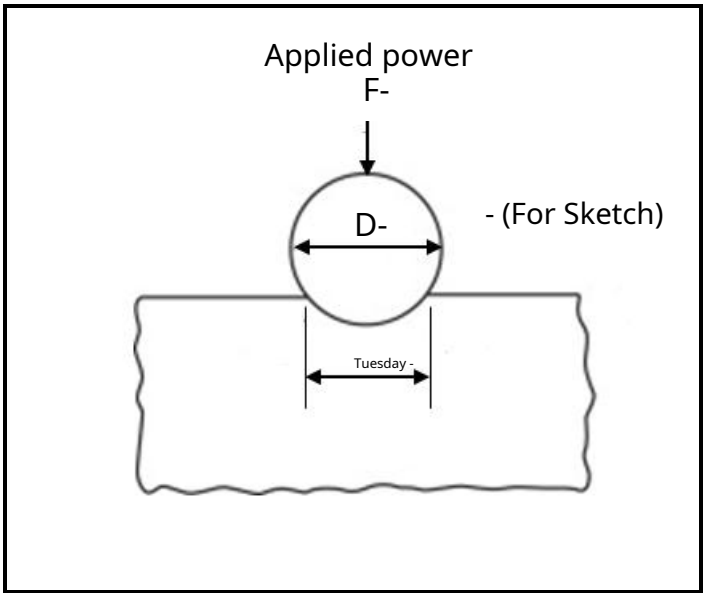
- Avoid vibrations. -
- Prevent poor finish / ensure better finish. - Prevent
- wear on bearings / components. -
- Prevent accidents. -
- Improve production.- Promote
- accuracy. - Prevent damage to
- workpiece. - Prevent components
- from coming loose. -

(Any 2 x 1) (2)
[28]

QUESTION 7: TOOLS AND EQUIPMENT (SPECIFIC)

7.1 **Function of thread micrometer:**
The thread micrometer is specifically designed to measure the pitch diameter - of a thread. - (2)

7.2 **Brinell labeled sketch:**



(4)

7.3 **Type of forces:**

- Traction -
- thrust force -
- shear force -
- Torque -
- Gravitational Force -
- Normal power -
- Frictional Force -
- reaction force -

(Any 2 x 1) (2)

7.4 **ISO-Metric thread:**

7.4.1 A – Root/Root level -
B – Stitch diameter / Effective diameter / Average diameter -
C – Crown diameter / Large diameter / Outside diameter / Basic diameter - (3)

7.4.2 **Stitch Diameter:**
Dp = Dn – (0.866 x P)

Dp = 12 – (0.866 x 1.75) -

Dp = 12 – 1.52

Dp = 10.48 mm - (2)

[13]

QUESTION 8: POWERS (SPECIFIC)

8.1 **Powers:**

8.1.1 **Horizontal component:**

-HK -25cos90- - 40cos0- - 55cos70- -120cos30-

-HK - 0 - 40 - - 18.81 - 103.92 -

-HK - -45,11N- (4)

8.1.2 **Vertical component:**

-UK - 25sin90- -40sin0- - 55sin70- -120sin30-

-UK - 25 - - 0 - 51.68 - - 60

-UK -- 86.68N- (4)

OR

Force	***θ***	8.1.1 ∑HK/**x = Fcosθ**		8.1.2 ∑VK/**y = Fsinθ**	
25N	90°	HK = 25cos90°	0N	UK = 25sin90°	25N -
40N	0°	HK = 40cos0°	40N -	UK = 40sin0°	0N
55N	290°	HK = 55cos290°	18.81N -	UK = 55sin290°	- 51.68N -
120N	210°	HK = 120cos210°	- 103.92N -	UK = 120sin210°	- 0N -
		Total	**- 45.11N**-		**- 86.68N**-

(8)

8.1.3 **Resultant:**

R^2 - UK^2-HK^2

R - $\sqrt{\text{--86.68-}^2\text{--45,11-}^2}$ -

R - $\sqrt{9549.24}$

R - 97.72N - (2)

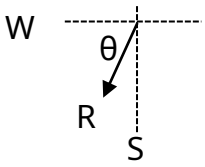
8.1.4 **Angle and direction of resultant:**
Angle:

$$\tan\theta = \frac{UK}{HK}$$

$$\theta = \tan^{-1}\left(\frac{86.68}{45,11}\right)$$

$$\theta = \tan^{-1}(1.92)$$

$$\theta = 62.5°$$



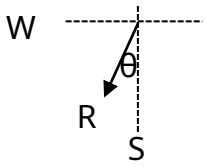
OR

$$\tan = \frac{HC}{VC}$$

$$= \tan^{-1}\left(\frac{45.11}{86.68}\right)$$

$$= \tan^{-1}(0.52)$$

$$= 27.49°$$



Direction:
R - 97.72N 62.5° South of West
OR
R - 97.72N 27.5° West of South (3)

8.2 **EVL bar:**

8.2.1 **Distributed load:**
Uniform distributed load: 7 x 12 m = 84 N (1)

8.2.2 **Reaction in strut A:**
Take moments to B:

$$-75(12.5) - 84(5.5) - 55(0) - A(14)$$

$$937.5 - 462 - 0 - 14A$$

$$A = \frac{1399.5}{14}$$

$$A = 99.96N$$ (5)

8.2.3 **Reaction in strut B:**
Take moments to A:

- -
-B-14---- 75-1.5---84-8.5---55-14-

14B -112.5 - 714- 770

$$B - \frac{1596.5}{14} -$$

B -114.04N -

(5)

8.3.1 **Resistance Area:**

$$\sigma - \frac{F}{A}$$

$$A - \frac{F}{\sigma} \quad -$$

$$A - \frac{85 - 10^3}{36 - 10^6} \quad -$$

A - 2.36 - 10^{-3}m^2 - (3)

8.3.2 **Change in length:**

$$E - \frac{\sigma}{\varepsilon}$$

$$\varepsilon - \frac{\sigma}{E} \quad -$$

$$\varepsilon - \frac{36\text{-}10^6}{90\text{-}10^9} \quad -$$

ε-4-10^{-4} -

$$\varepsilon - \frac{\Delta L}{L}$$

ΔL-ε-L -

ΔL-4-10^{-4}-0.12 ΔL- -

4.8-10^{-5}m ΔL--4.8-10^{-5}-

-1000 ΔL-0.048 mm -

(6)
[33]

QUESTION 9: MAINTENANCE (SPECIFIC)

9.1 **Failure to perform preventive maintenance:**
-Risk of injury or death. -
-Financial loss due to damage from part failure. -

- Loss of precious production time. -
- Discharge of equipment. - Damage
- to material or project. - (3)

9.2 **Mechanical drives:**
- Belt Drives -
- gear drives -
- Chain Drives -
- Hydrostatic drives -
- Hydraulic drive - Cable drive
- -
- Pneumatic drive -

(Any 3 x 1) (3)

9.3 **Increase the strength of fiberglass:** Polyester resin / resin*(Polyester resin / resin)*- (1)

9.4 **Characteristics:**

9.4.1 **Bakelite:**
- Sturdy -
- strong -
- Hard / abrasion resistant -
- Chemical resistance -
- thermoset -
- Water Resistant -
- electrical insulation -
- heat resistant -
- machinable -
- brittleness -

(Any 2 x 1) (2)

9.4.2 **Carbon fiber:**
- Good fatigue resistance - Heat
- resistance -
- tough -
- strong -
- Semi-rigid -
- Good chemical resistance -
- Light weight -
- Water Resistant -
- flexible -

(Any 2 x 1) (2)

9.5 **Thermoplastic composition:**

- oil -
- Salt -
- coal -

(Any 1 x 1) (1)

9.6 **Measures for performing preventive maintenance:**

- inspection -
- Measurement -
- Cleaning -
- Lubrication -
- Adjustment of parts -
- Replacement of parts - Tests
- -

(Any 3 x 1) (3)

9.7 **Main types of plastic compounds:**

- Thermoplastics -
- Thermosetting composition - (2)

9.8 **Non-stick coating in frying pans:**

Teflon - (1)

[18]

QUESTION 10: SUTURE METHODS (SPECIFIC)

10.1 **Thread Terminology:**

10.2.1 **Rise:**
This is the distance - that the point (nut/bolt) on a thread will move/advance - with the thread axis - along, when turned through one complete revolution. - (4)

10.2.2 **Helix angle:**
This is the angle that the thread makes with the line that is perpendicular / 90° - to the axis of the thread. - (2)

10.2 **Square thread:**

10.2.1 **Stab:**

Rise = Stitch - number of starts

$$\text{Stitch} = \frac{\text{Rise}}{\text{number of starts}}$$

$$= 42$$

$$= 21\text{mm}$$ (3)

10.2.2 **Stitch Diameter:**

$$\text{SD - BD-} \frac{P}{2}$$

$$\text{-90-} \frac{21}{2}$$

-79.50 mm (2)

10.2.3 **Helix angle of wire:**

$$\tan\alpha = \frac{\text{Rise}}{\pi \text{SD}}$$

$$\tan\alpha = \frac{42}{\pi 79.50}$$

$$\tan\alpha = 0.168163713$$

$$\alpha = \tan^{-1} 0.168163713$$

$$= 9.55^{\circ} \text{ or } 9^{\circ}33'$$ (3)

10.2.4 **Angle of intervention:**

Angle of engagement = 90° - (helix angle + freewheel angle)

= 90° - (9.55° + 3°) - =

77.45° or 77°27'- (2)

10.2.5 **Drag angle:**

Drag angle = 90° + (helix angle – freewheel angle)

= 90° + (9.55° - 3°) - =

96.55° or 96°33'- (2)

[18]

QUESTION 11: SYSTEMS AND CONTROL (PROPULSION SYSTEMS) (SPECIFIC)

11.1 Hydraulic calculations:

11.1.1 The fluid pressure in the hydraulic system in MPa:

$A_{Ram} = \frac{\pi d^2}{4}$

$A = \frac{\pi(0.25)^2}{4}$

$A = 0.049\ m^2$ OR $4.91 \times 10^{-2} m^2$

$p = \frac{F}{A}$

$p = \frac{34000}{0.049}$

$p = 693877.55\ Pa$

$p = 0.69\ MPa$ (4)

11.1.2 **Diameter of the plunger:**

$p = \frac{F}{A}$

$A = \frac{F}{p}$

$A = \frac{215}{693877.55}$ -

$A = 0.309852 \times 10^{-3} m^2$ -

OR

$\frac{F_1}{A_1} = \frac{F_2}{A_2}$

$\frac{F_1}{\frac{\pi d_2}{4}} = \frac{F_2}{\frac{\pi D_2}{4}}$

$\frac{215}{d_2} = \frac{34000}{250^2}$ -

$d_2 \times 34000 = 215 \times 250^2$

$A = \frac{\pi d^2}{4}$

$d = \sqrt{\frac{4 \times A}{\pi}}$ -

$d = \sqrt{\frac{4 \times 0.309852 \times 10^{-3}}{\pi}}$

$d = 0.019862422$ m

$d = 19.86$ mm -

$d = \sqrt{\frac{215 \times 250^2}{34000}}$ -

$d = 19.88$ mm -

(5)

11.2 **Hydraulic filters:**

- Pressure Line Filter -
- Running Back Training Filter -

(2)

11.3 **Hydraulic symbols:**

11.3.1 Reservoir - (1)

11.3.2 Directional Control Valve / Check Valve / One Way Valve - (1)

11.4 **Belt drive:**

11.4.1 **The rotation frequency in r/sec:**

A_{Dr}-D - N_{Dr} $_{God}$ -D_{God}

$$A_{God} = \frac{A_{Dr} \cdot D_{Dr}}{D_{God}}$$

$$A_{God} = \frac{1330 \cdot 0.15}{0.32}$$

$$A_{God} = \frac{623.44 \text{ r/min}}{60}$$

A_{God} = 10.39 r/sec (3)

11.4.2 **Power transferred in Watts:**

$$P = \frac{(T_1 - T_2) \cdot DN}{60}$$

$P = (175 \cdot 130) \cdot \pi \cdot 0.32 \cdot 10.39$

P = 470.03 Watts

OR

$$P = \frac{(T_1 - T_2) \cdot DN}{60}$$

$P = (175 \cdot 130) \cdot \pi \cdot 0.15 \cdot 1330$

P = 470.03 Watts (4)

11.5 **Gear Drive:**

11.5.1 **Type of gear drive:**
Compound Gear System - (1)

11.5.2 **Rotation frequency of input shaft N_A:**

$$\frac{A_{input}}{A_{output}} = \frac{\text{Product of teeth on driven gears}}{\text{Product of teeth on drive gears}}$$

$$\frac{A_A}{A_F} = \frac{T_B - T_D - T_F}{T_A - T_C - T_E} \text{ -}$$

$$\frac{A_A}{625} = \frac{40\text{-}50\text{-}80 \text{ -}}{20\text{-}35 \text{ - } 25 \text{ -}}$$

$$A_A = \frac{40\text{-}50\text{-}80 \text{ - } 625}{20\text{-}35 \text{ - } 25}$$

A_A= 5714.29 r / min - (4)

11.6 **Torque on lathe spindle:**

Torque-T-=Power-Radius

- -
T -250-0.025

T - 6.25 Nm. - (3)
[28]

TOTAL: 200