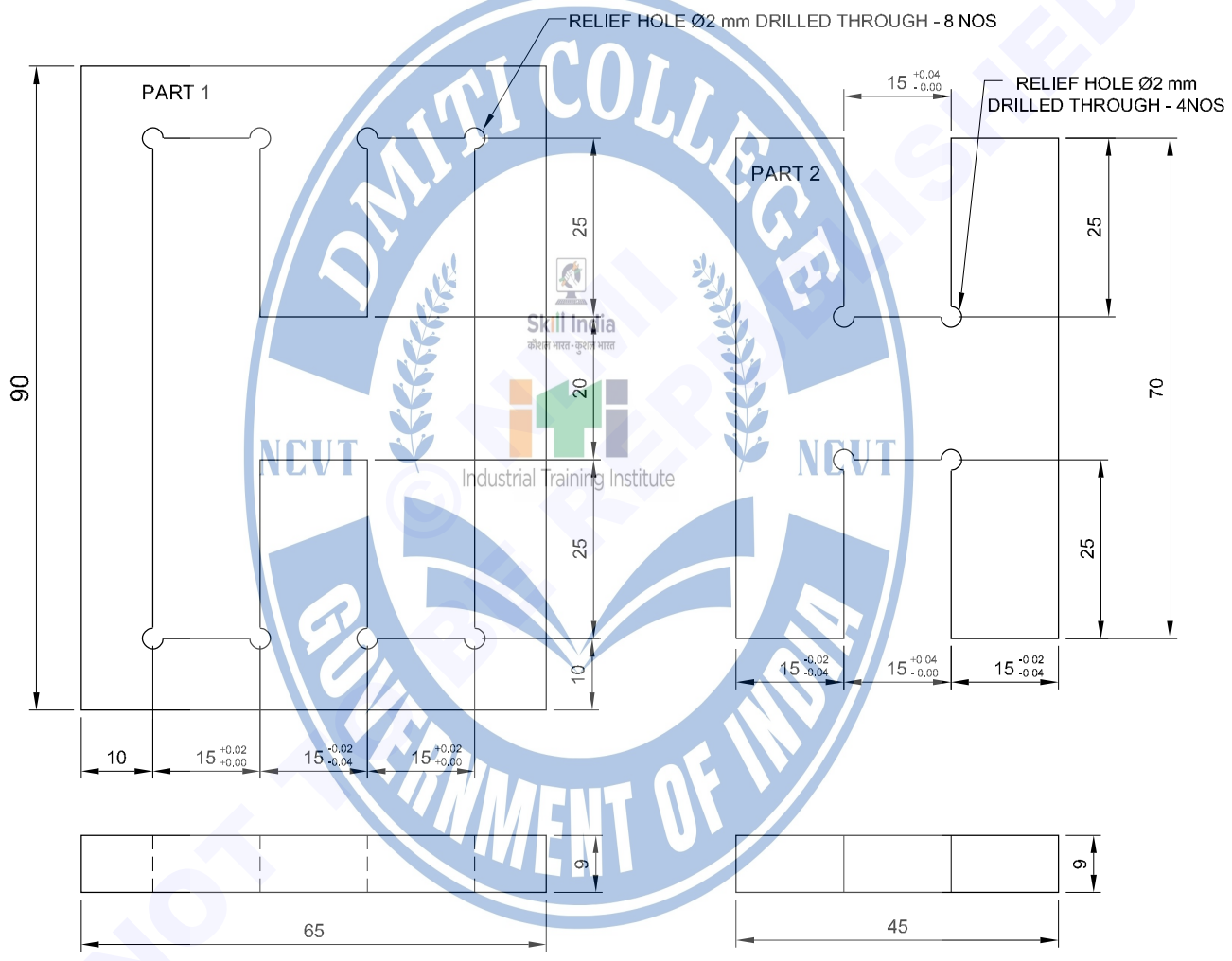
Make - H - Fitting

Objectives: At the end of this exercise you shall be able to

- **file flat, square and parallel to an accuracy of ± 0.02mm**
- **drilling, chain drilling and relief holes**
- **file profile to the given dimensions**
- **assemble part 1 and 2 as per drawing**
- **finish and de-burr.**

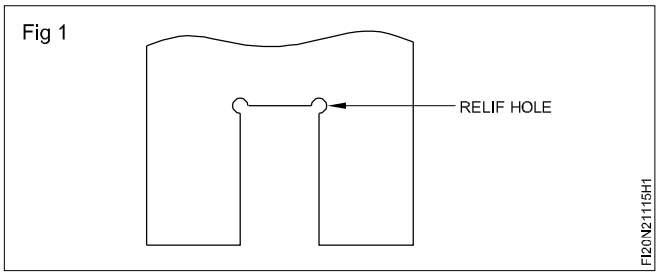


1	100 ISF 10 - 70	–	Fe310	–	1	2.1.115
1	50 ISF 10 - 75	–	Fe310	–	2	2.1.115
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1		MAKE H - FITTING			TOLERANCE : ± 0.02	TIME: 13 Hrs
					CODE NO. FI20N21115E1	

Job Sequence

- Check the size of raw material using steel rule for part 1 and 2.
- File surface and right angle on both part 1 and 2 and check by using try square.
- Apply marking media on part 1 and 2.
- Mark off part 1 and 2 as per given drawing dimensions, using 300 mm vernier height gauge.
- Punch witness marks on required lines, by using 60° Dot punch.
- Punch relief holes using centre punch.
- Make relief drill hole ∅ 2 at corners on part 1 and 2. (Fig 1)
- Remove unwanted material by chain drilling, Hacksawing and chipping.

Fig 1

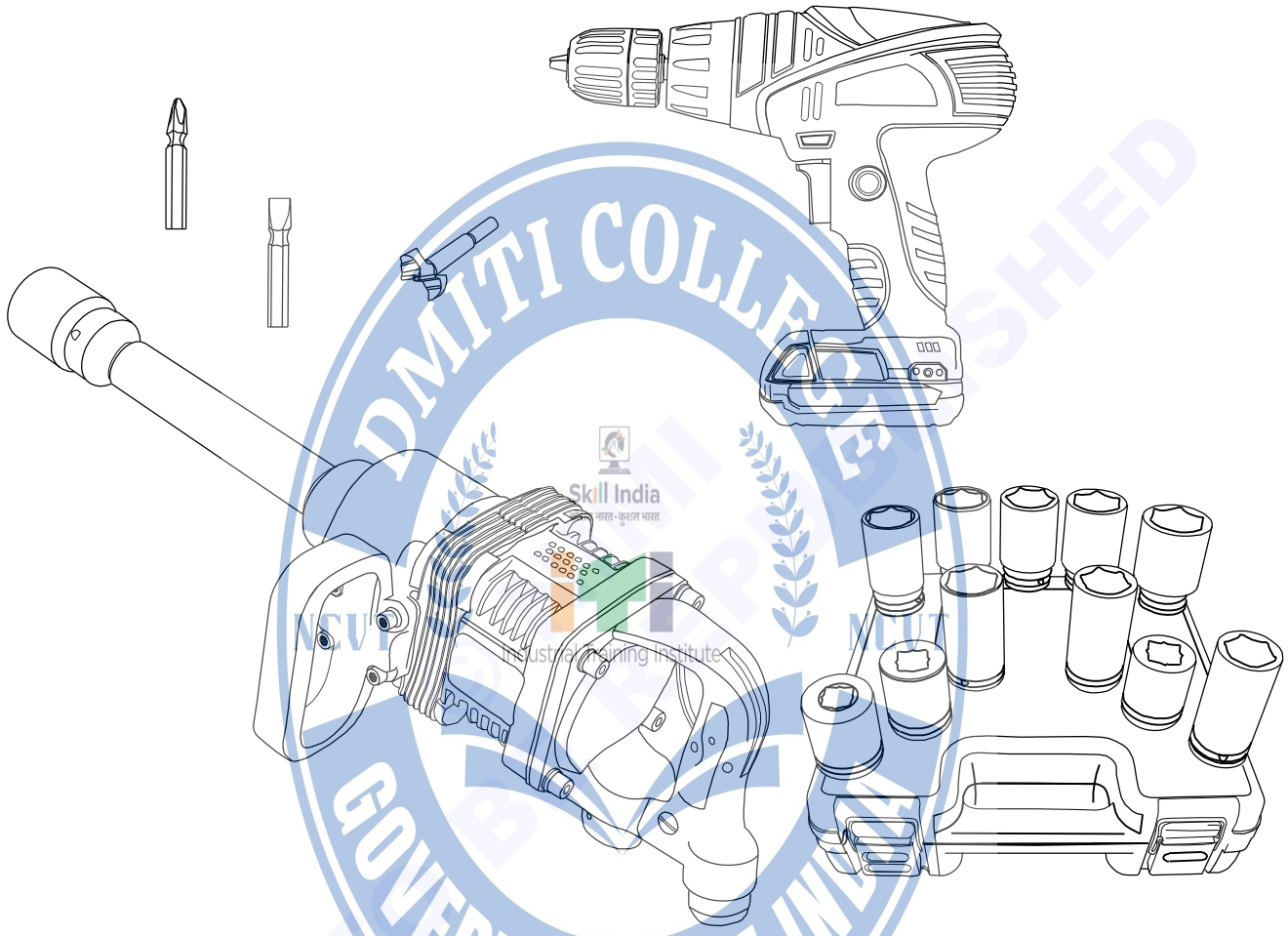


- File to size part 1 as per dimensions and measure the size by using outside micrometer/ vernier caliper.
- Finish part 1 and check the dimension using vernier caliper.
- Similarly finish part 2.
- Assemble part 1 and 2 and check for the slide fit.
- Apply thin coat of oil and preserve it for evaluation.
- Clean the work area and arrange the tools in order.

Power tools: Practice operation of power tool for fastening

Objectives: At the end of this exercise you shall be able to
- **identify various power tools**
- **practice the operation of power tools for fastening.**

Fig 1



POWER TOOL FASTENING ACCESSORIES

FI20N21116H1

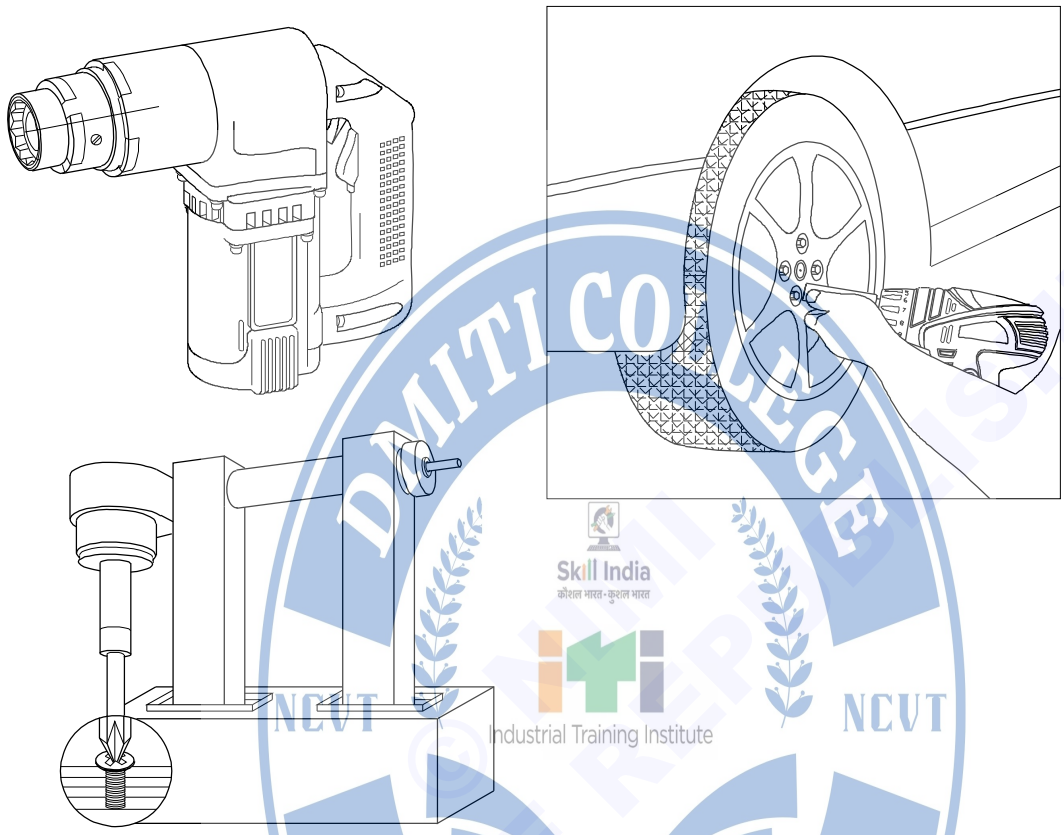
Job Sequence

- Identify the power tools.
- Follow the work operations required for the use of hand and power tools.
- Identify the source and access of power supply to power tools.
- Select the proper safety equipments such as safety goggles, hand gloves, boots, apron etc. and wear them.
- Check the tools for serviceablility and safety and if there is any faults, report the same to the concerned authority.
- Select and use the equipment to hold and support the power tools.
- Choose the sequence of operations to produce the desired outcome from power tools.
- Select the tool required for operation and fix it, according to need.
- Power tools should be cleaned and stored safely in appropriate location according to standard workshop procedure and manufacturer recommendations.
- Fasten the nut and bolt.
- Clean the power tool and keep it in safe place.
- Keep work area neat and clean.

Tightening of bolt/screw with specified torque

Objective: At the end of this exercise you shall be able to
- **tighten the bolt/screw with specified torque.**

Fig 1

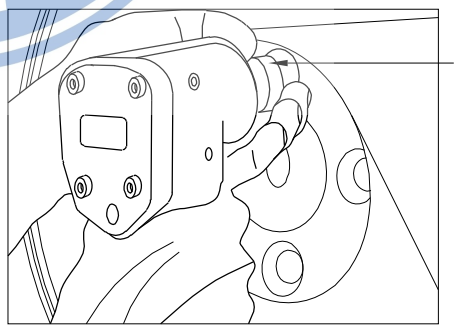


FI20N21117H1

Job Sequence

- Select a proper power tool for fastening.
- Select an impact wrench power tool operated by compressed air for tightening and loosening nuts.
- Check the air impact wrench is connected to the air lines.
- Select correct size of socket which can with stand sudden impact force. (Select six point impact socket).
- Fit the socket on the air impact wrench. (Fig 1).
- Set the direction of spin forward or backward with the help of wrench lever.
- Set the torque by turning the valve to increase or decrease.
- Insert the impact socket on the wheel leg nut.
- Trigger the switch of the impact wrench to loosen and remove the nut.

Fig 1

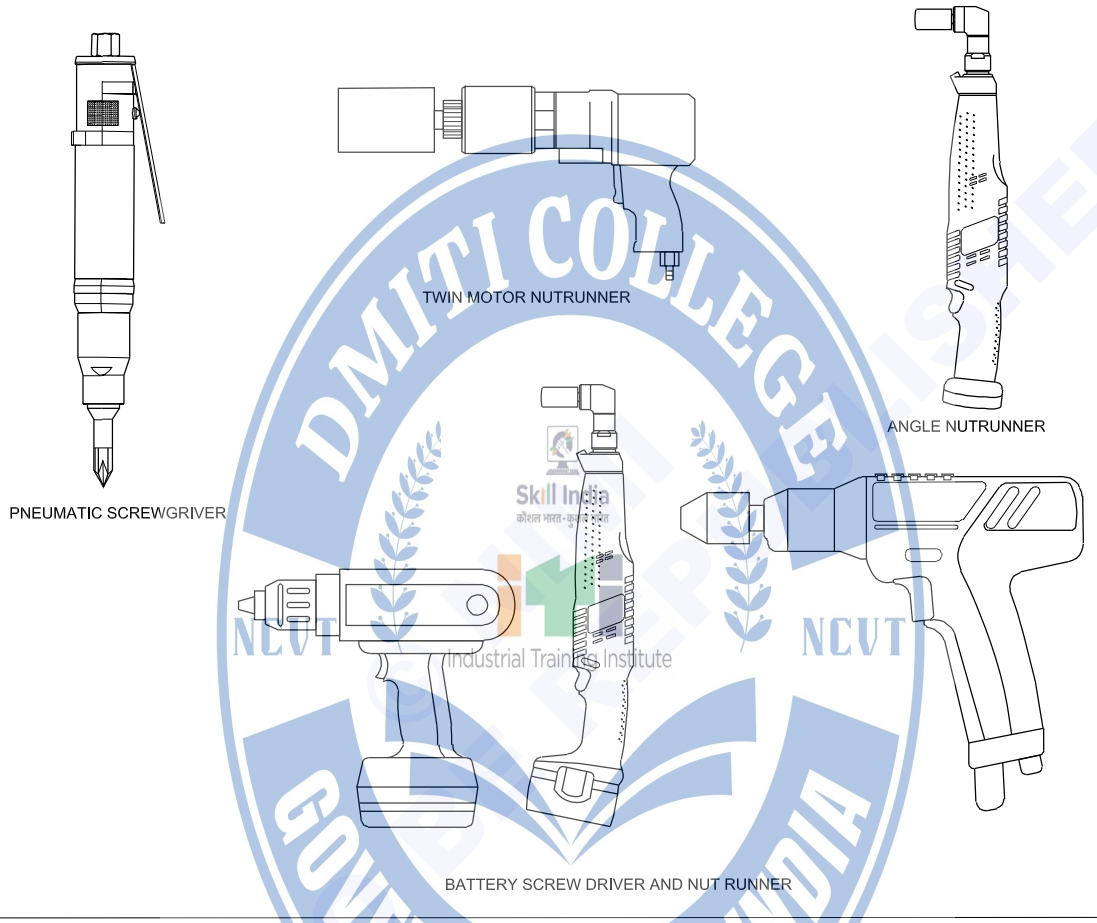


FI20N21117J1

Selection of right tool as for tightening or loosening of screw/bolt as per accessibility

Objectives: At the end of this exercise you shall be able to
- **record the tools required for the following applications**
- **select right tool for tightening and loosening of screw/bolt.**

Fig 1



Note:
Instructor should display the required power tools and demonstrate the trainees for tightening and loosening of screw/bolt.
Ask the trainees to write the tool name for application in the Table 1.

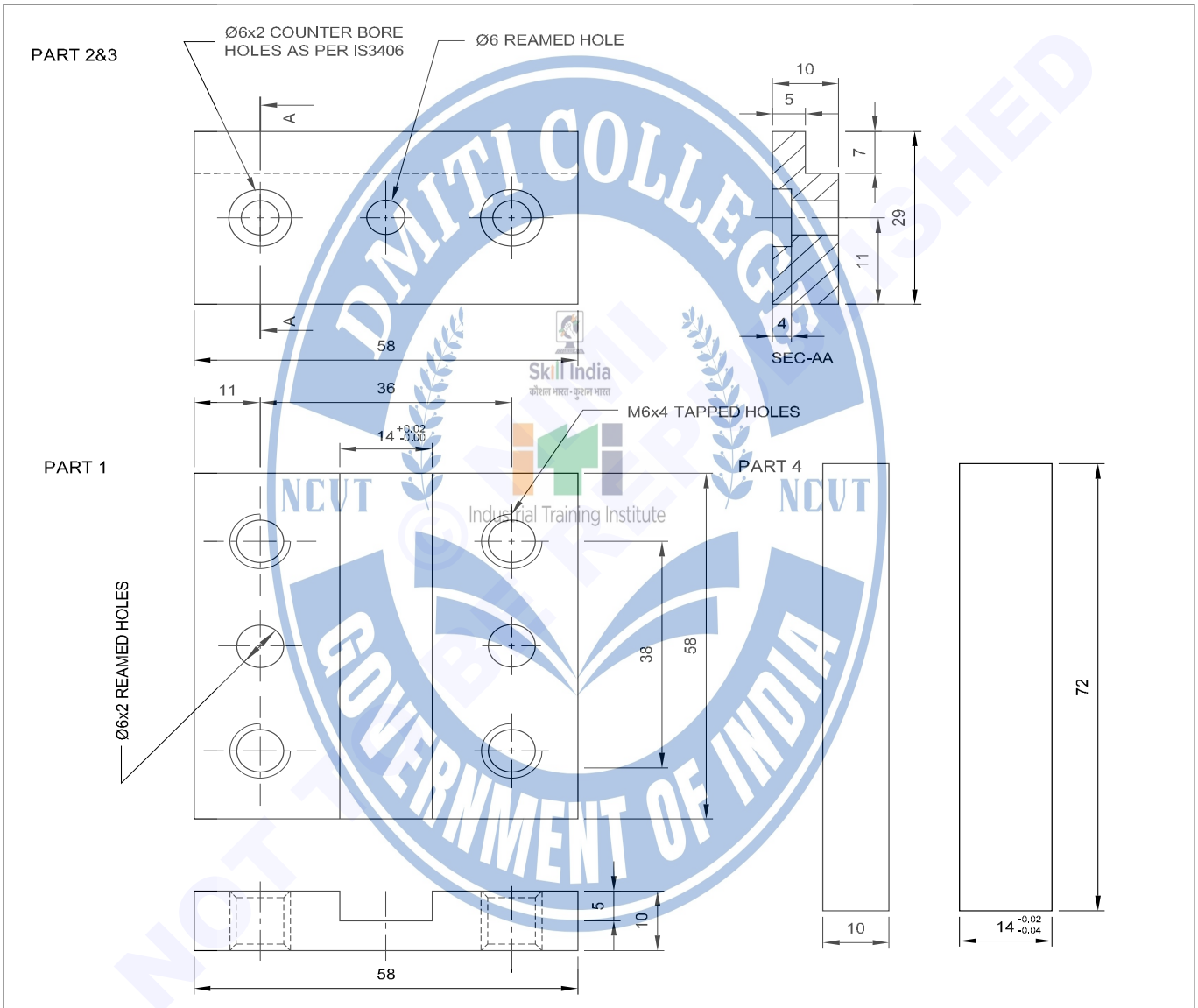
Table - 1

Applications	Tools required
Loosening and tightening of large dimension bolts during maintenance. High torques with moderate accuracy requirements.	
Assembly of machines screws where speed and handiness are important. Medium accuracy.	
Small screw assembly at low torque and medium high accuracy.	
Assembly of machine screws at low torque and medium to high accuracy.	
Assembly of machine screws and nuts where accuracy reqiurements are high. Bolts with limited accessibility.	
Assembly of machine screws where in the tightening process the torque and/ or angle must be monitored for quality control and certification.	
Application where the counting of properly tightened screws in a joint is essential for product quality control.	
Assembly where in the tightening process control to a high level of accuracy is necessary.	
Applications where articulated arms are used to support the reaction torque for multiple spindle tightening and for automatic systems.	
For maximum mobility and where the air hose or electric cable would limit access or pose a safety risk from a jammed cable	

Assembly sliding for using keys, dowel pin and screw, ± 0.02 mm accuracy on plain surface and testing of sliding fitting job

Objectives: At the end of this exercise you shall be able to

- **mark dimensions with vernier height gauge**
- **file part 1,2,3,4, to size**
- **drill, ream and tap at correct location**
- **counter bore to the required depth**
- **assemble part 1,2,3,4 with dowel pins and cheese head screws.**



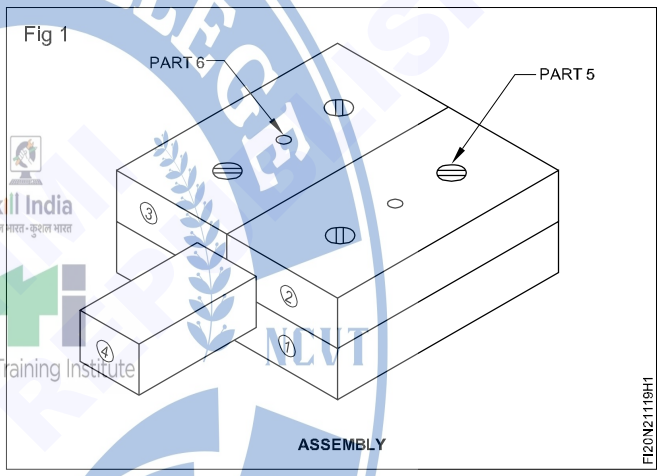
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
2	Ø6-20	DOWEL PIN	FE310	–	6	2.1.119
4	M6-20	CHEESE HD SCREW	FE310	–	5	2.1.119
1	75 ISF 12-16	KEY	FE310	–	4	2.1.119
2	65 ISF 12-35	TOP PLATES	FE310	–	2&3	2.1.119
1	65 ISF 12-65	BASE PLATE	FE310	–	1	2.1.119

SCALE : 1:1	ASSEMBLY SLIDING FOR USING KEYS, DOWEL PIN AND SCREW, ± 0.02 mm ACCURACY ON PLAIN SURFACE AND TESTING OF SLIDING FITTING JOB	TOLERANCE : ±0.02mm	TIME: 13 Hrs
		CODE NO: FI20N21119E1	

Job Sequence

- Check the raw materials for its size.
- File the parts 1,2,3 and 4 to its overall sizes maintaining accuracy ± 0.02 mm with flatness and squareness.
- Mark the dimension and location of holes as per drawing on part 1,2 and 3 by using Vernier height gauge.
- Punch witness marks.
- Punch on the location of holes on parts 1,2, and 3 using centre punch.
- File to size and shape in part 2 and 3 maintaining accuracy ± 0.02 mm with flatness and squareness.
- Set all four pieces together and clamp them with parallel clamps and check the squareness by using try square.
- Hold all the pieces together along with clamps on a drilling machine table and centre drill on part 2, and 3 in all hole locations.
- Remove the centre drill from the drill chuck and fix ∅ 5.8 mm twist drill and drill through hole on part 2 to fix dowel pin without disturbing the position of job.
- Ream the drilled hole with ∅ 6 mm hand reamer with tap wrench without disturbing the position of the job.
- Clean the reamed hole and fix ∅ 6 mm dowel pin in the assembly.
- Similarly, drill other drill hole, ream and fix dowel pin in part 3 without disturbing the assembly.
- Fix ∅ 5 mm twist drill and drill through hole on part 1 and 2 in assembly without disturbing the job to cut M6 internal thread in part 1 to fix cheese head screw.
- Similarly, drill ∅ 5 mm other drill through holes in part 1, 2 and 3 without disturbing the job to cut M6 internal thread in part 1.
- Disassemble the setting and separate the part 1, 2, 3 and 4 of job pieces.
- Fix counter bore tool in drilling machine spindle and counter bore in part 2 and 3 to fix M6 cheese head screw.
- Fix counter sink tool and chamfer both ends of internal thread cutting holes 1mm x 45° in part 1.
- Hold the part 1 in bench vice and cut M6 internal thread in all four holes.
- Clean the threads without burrs.
- Finish file on all the parts and de-burr in all the corners of the jobs.
- Assemble all the parts 1,2,3 and 4 as shown in job drawing. (Fig 1)
- Apply thin coat of oil and preserve it for evaluation.

Fig 1



Skill Sequence

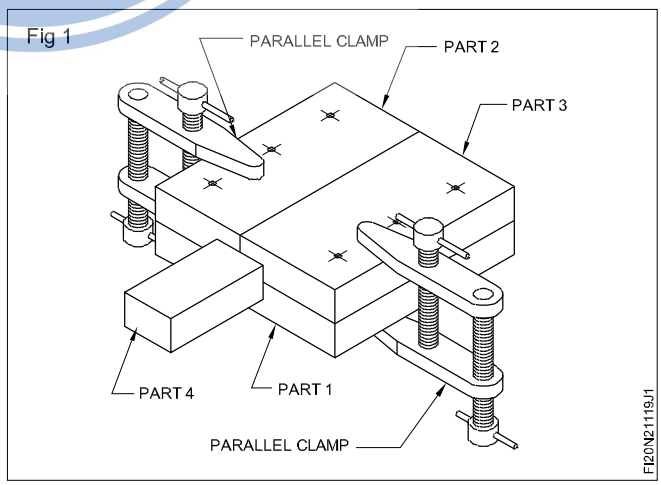
Assembly

Objective: This shall help you to

- **assemble the parts together for drilling process to avoid mis-alignment of job setting.**

- keep two parallel blocks on a surface plate
- keep part 1 over the parallel block horizontally
- position part 2 on top of left side of part 1 and check the squareness of part 1 & 2 by using try square and clamp it by using parallel clamp
- simultaneously position part 3 on top of right side of part 1, check the squareness, by using try square, insert the part 4 in between gap and then clamp it by using parallel clamps.

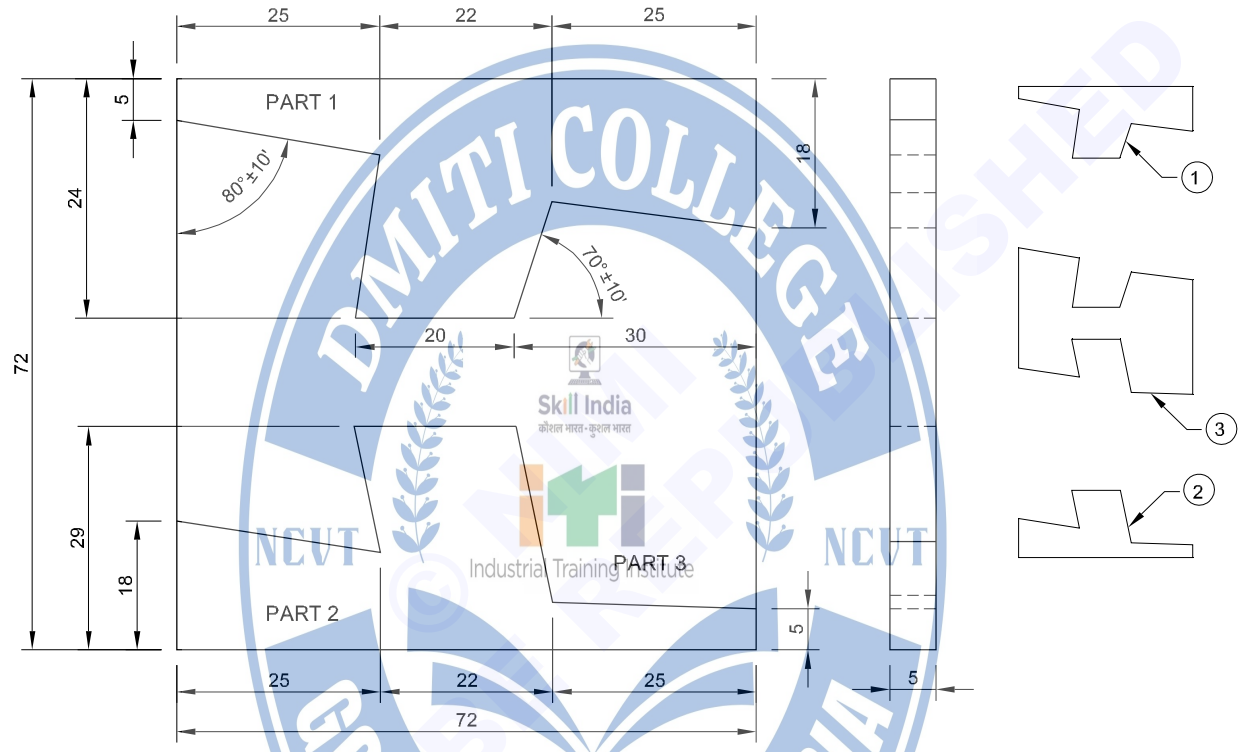
Fig 1



File & fit angular mating surface within an accuracy of ± 0.02 mm & 10 minutes angular fitting

Objectives: At the end of this exercise you shall be able to

- **mark angular outlines of part 1,2,3 with an accuracy of ± 10′ accuracy**
- **file part 1,2,& 3 maintaining the accuracy of ± 0.02 for fitting**
- **assemble the part 1,2 & 3.**
- **finish and de-burr.**



Job Sequence

- Check the raw material for its size.
- File surface and right angle and mark off part 1,2 & 3 with vernier height guage and vernier bevel protractor.
- Punch on the marked lines.
- Remove excess materials by hacksawing & chain drilling.
- File part 1, 2 & 3 with an linear accuracy of ± 0.02 mm and angular of ± 10'
- Check the linear dimensions with vernier caliper and angular by vernier bevel protractor.
- Fit part 1, 2 & 3 simultaneously and finish.
- Apply little oil for preservation and evaluation.

- **Do not mark angular dimension/angle by scale/set square while marking.**
- **Do not make a force fit**

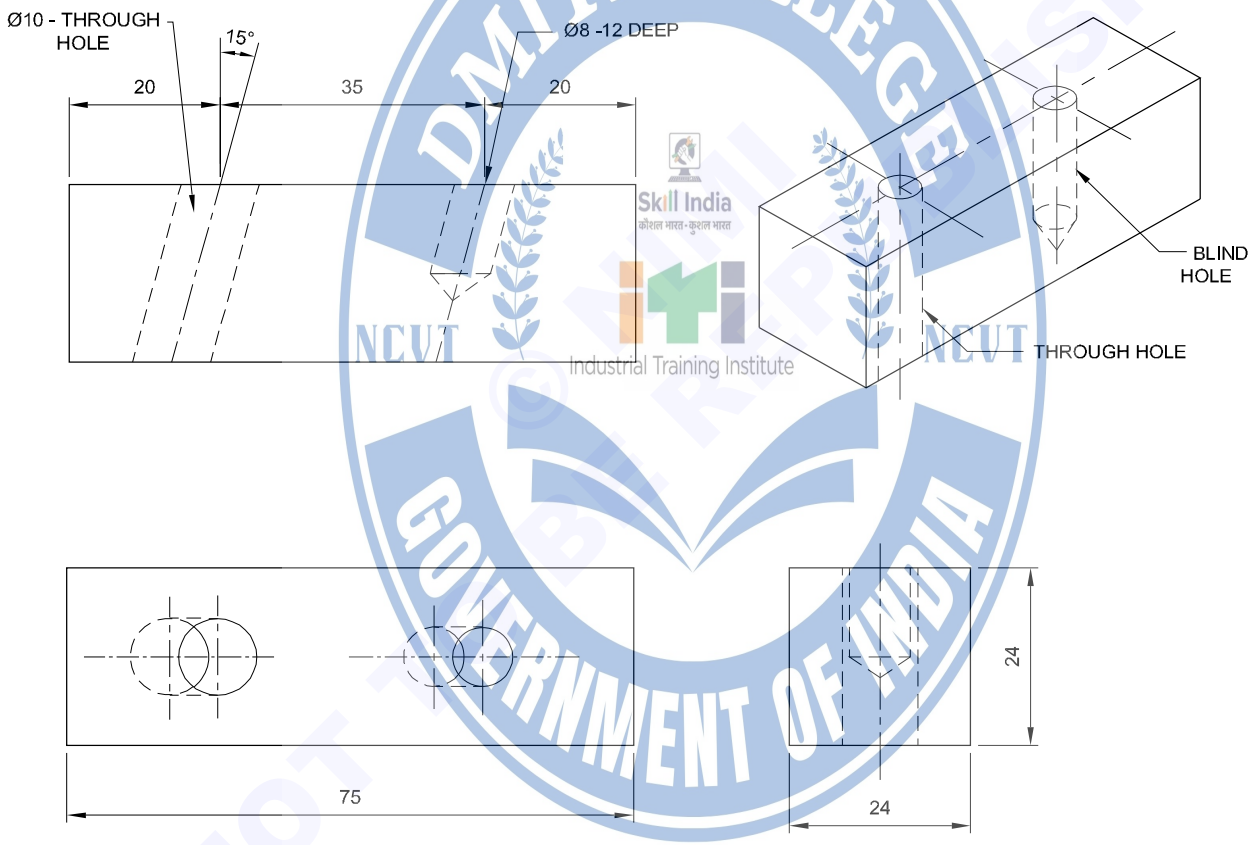
1	65 ISF 6 -75		Fe310		3	
1	35 ISF 6 - 75		Fe310		2	
1	30 ISF 6 - 75		Fe310		1	2.1.120
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : 1.1	**FILE AND FIT ANGULAR MATTING SURFACE WITHIN AN ACCURACY OF ± 0.02 mm & 10 MINUTES ANGULAR FITTING**	TOLERANCE : ±0.02 mm	TIME: 12 Hrs
		CODE NO: FI20N21120E1	

Drill through and blind holes at an angle using swivel table of drilling machine

Objectives: At the end of this exercise you shall be able to

- **file surface and right angle and check with try square**
- **file to size maintaining accuracy ± 0.02mm**
- **align the job for angular drilling**
- **drill angular through hole**
- **drill angular blind hole.**



1	SQ 25-80	–	Fe310	–	1	2.1.121
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : 1:1	DRILL THROUGH AND BLIND HOLES AT AN ANGLE USING SWIVEL TABLE OF DRILLING MACHINE				TOLERANCE : ±0.02 mm	TIME: 9 Hrs
					CODE NO: FI20N21121E1	

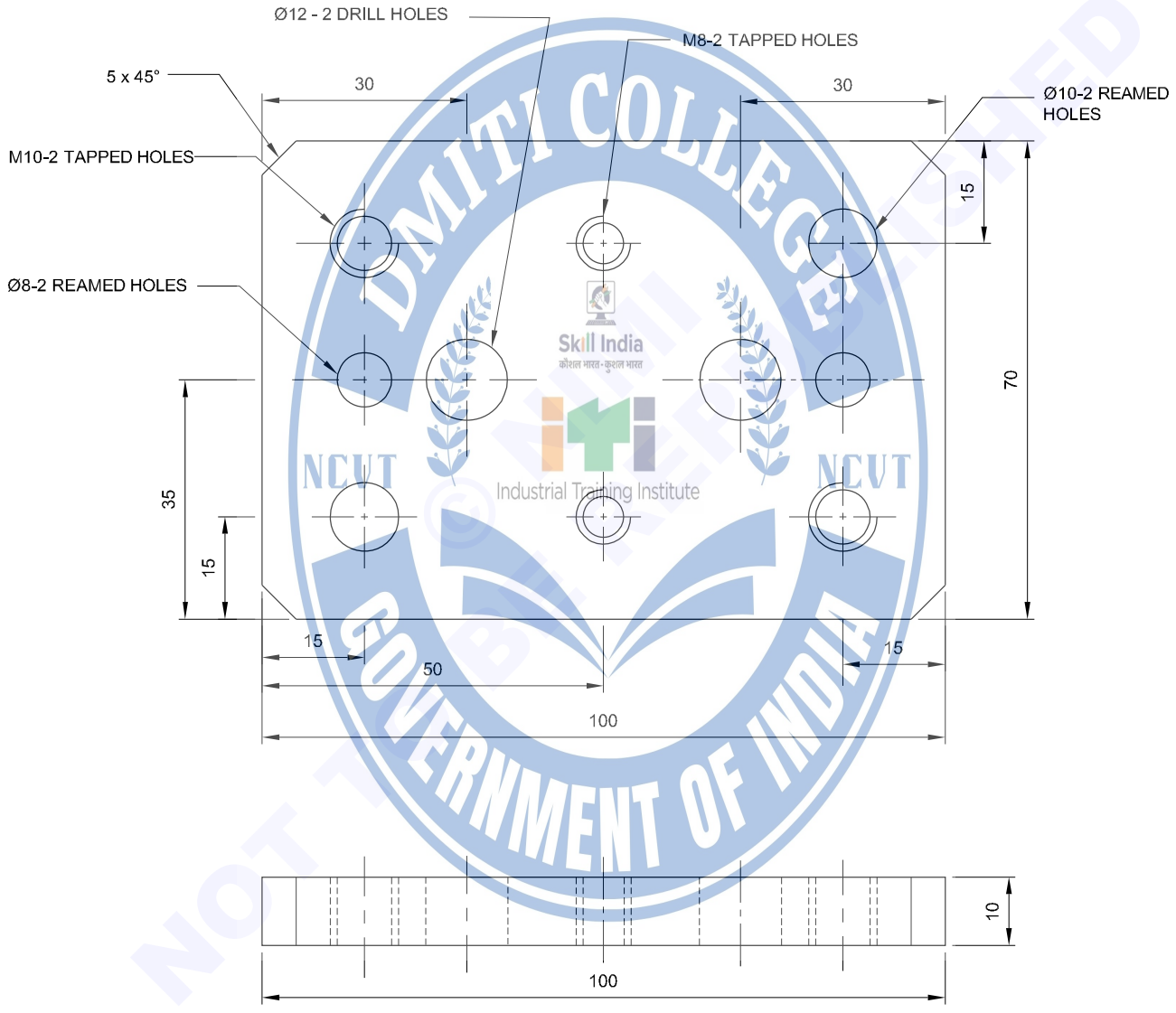
Job Sequence

- Check the raw material for its size.
- Mark the required size and cut by hacksawing.
- File to size 75x24x24mm and check with vernier caliper.
- Mark the given dimension for drilling location as per size by using vernier height gauge.
- Punch on correct locations of drills
- Hold the work piece in the machine horizontally by keeping the parallel blocks under the work piece to avoid drill bit tip touch the metal base of machine vice.
- Check with spirit level.
- Clamp the machine vice to the drilling machine universal table.
- Lock and arrest the table rotation in 'z' axis.
- Tilt the drilling machine table at an angle of 15°, lock it, and drill hole to the required depth.
- Align the spindle centre and hole location using locating pin.
- Centre drill the hole, till it reaches the formation of cone.
- Drill a ∅ 8 mm to a depth of 12 mm as shown in drawing using depth bar.
- Align the spindle centre to another hole location.
- Centre drill the hole slowly feed the centre drill till it reaches the formation of cone.
- Drill a ∅ 10 mm to full depth.
- Deburr and clean the job.
- Apply thin layer of oil and preserve it for evaluation.

Precision drilling, reaming and tapping and test - job

Objectives: At the end of this exercise you shall be able to

- **file and finish the job to the over all size.**
- **chamfer all the corners**
- **drill, ream & tap at specified location**
- **check using plug gauge & thread plug gauge**
- **finish and deburr.**



1	75 ISF 12 - 105	–	Fe310	–	-	2.1.122
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : 1:1	**PRECISION DRILLING,REAMING AND TAPPING AND TEST- JOB**				TOLERANCE : ±0.02 mm	TIME: 12 Hrs
					CODE NO: FI20N21122E1	

Job Sequence

- Check the raw materials for its size.
- File the raw material to its overall dimension 100 x 70 x 10 mm.
- Mark the dimensional lines for location of holes as per drawing.
- Punch the centre punch marks on the location of holes and witness mark on the object line.
- Hold the work piece on a drilling machine table with machine vice.
- Keep the parallel blocks under the work piece in machine vice.
- Hold the centre drill in drilling machine spindle through drill chuck and drill centre drill holes on all the holes punched locations.
- Set the drilling machine spindle speed according to the diameter of drill and material.
- Remove the centre drill and fix ∅ 7.8 mm drill through holes as per drawing.
- Set the spindle speed, fix drills ∅ 8.5 mm, ∅ 7.0 mm, ∅ 9.8mm, ∅ 12 mm drill through holes as per drawing.
- Hold the counter sink tool and chamfer all the drilled holes on both sides of job 2 mm x 45°.
- Ream ∅ 8 mm holes using hand reamer.
- Check the reamed holes using suitable cylindrical plain plug gauge.
- Cut M8 and M10 internal threads using hand tap and tap wrench.
- Clean the burrs in the threaded holes.
- Check the threaded holes using thread plug gauge.
- File the chamfer portion 5mm X 45° angle using flat file (using bastard and smooth grade of files).
- Check the chamfer angle with vernier bevel protractor to an angular accuracy ± 5'.
- Finish and remove burrs on all surfaces and corners of the job.
- Apply a little oil and preserve it for evaulation.

Skill Sequence

Reaming drilled holes using hand reamers

Objective: This shall help you to

- **ream through holes within limits and check reamed holes with cylindrical pins.**

Determining the drill size for reaming

Use the formula,

drill diameter = reamed hole size - (undersize + oversize)

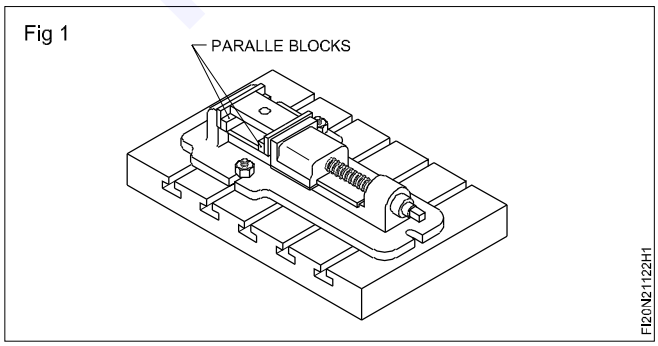
Refer to the table for the recommended undersizes in Related Theory on DRILL SIZES FOR REAMING.

Hand reaming

Drill holes for reaming as per the sizes determined.

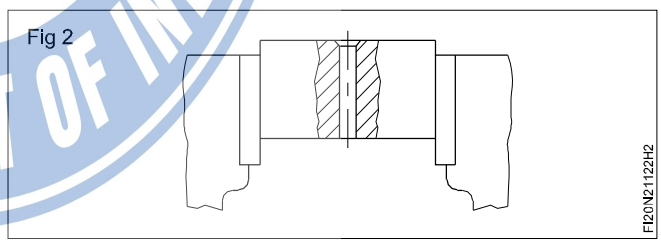
Place the work on parallels while setting on the machine vice. (Fig 1)

Fig 1



Chamfer the hole ends slightly. This removes burrs, and will also help to align the reamer vertically (Fig 2). Fix the work in the bench vice. Use vice clamps to protect the finished surfaces. Ensure that the job is horizontal.(Fig 2)

Fig 2

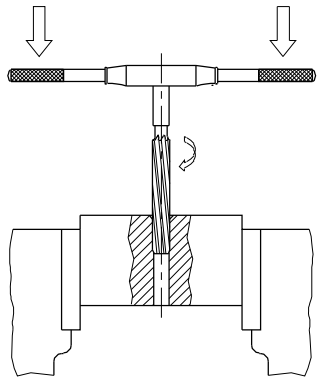


Fix the tap wrench on the square end and place the reamer vertically in the hole. Check the alignment with a try square. Make corrections, if necessary.Turn the tap wrench in a clockwise direction applying a slight downward pressure at the same time (Fig 3). Apply pressure evenly at both ends of the tap wrench.

Apply cutting fluid.

Turn the tap wrench steadily and slowly, maintaining the downward pressure.

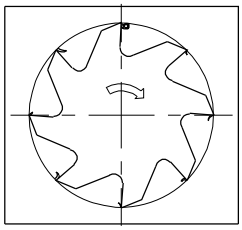
Fig 3



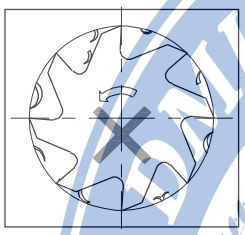
FI20N21122H3

Do not turn in the reverse direction it will scratch the reamed hole. (Fig 4)

Fig 4



CORRECT



WRONG

FI20N21122H4

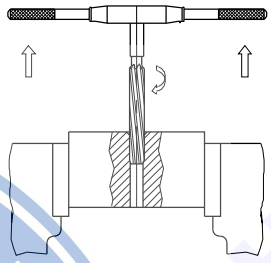
Ream the hole through. Ensure that the taper lead length of the reamer comes out well and clear from the bottom of the work. Do not allow the end of the reamer to strike on the vice.

Remove the reamer with an upward pull until the reamer is clear of the hole. (Fig 5)

Remove the burrs from the bottom of the reamed hole.

Clean the hole. Check the accuracy with the cylindrical pins supplied.

Fig 5

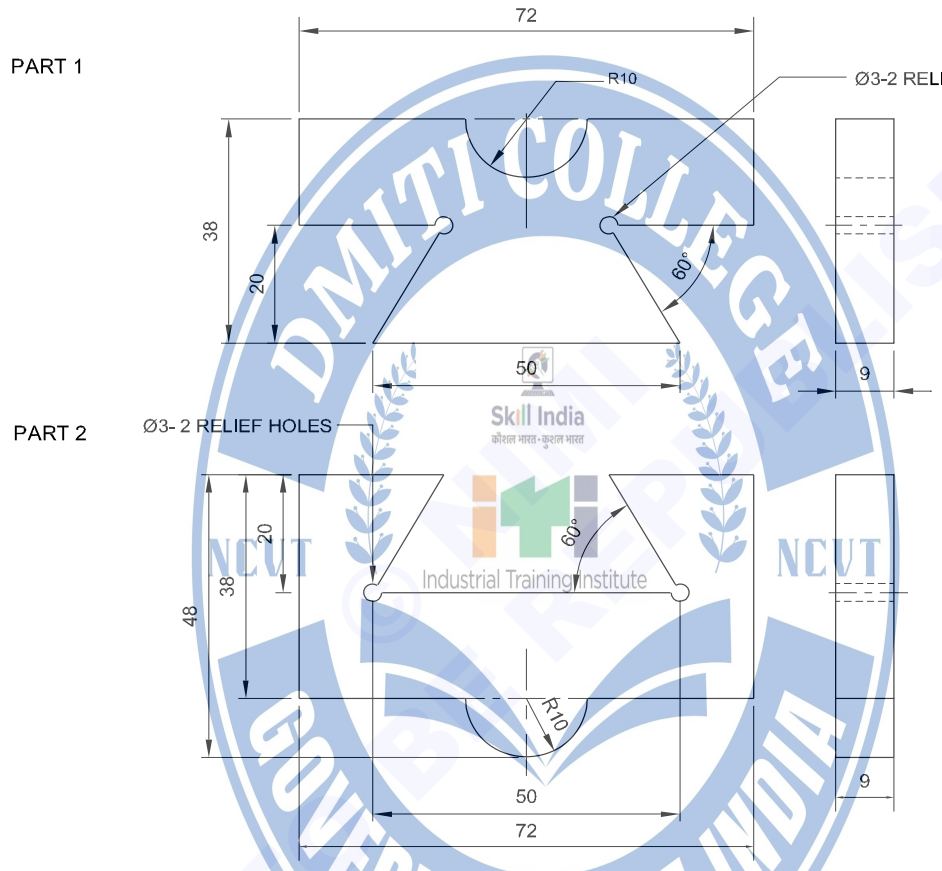


FI20N21122H5

Make dovetailed fitting and radius fitting

Objectives: At the end of this exercise you shall be able to

- **file and finish to overall size on part 1 and 2**
- **mark off dimensions and radius by divider**
- **remove excess material by chain drilling on part 2**
- **fix male and female parts and assemble**
- **finish and deburr.**



Job Sequence

- Check the raw material for its size.
- File and finish part 1 and 2 for the over all dimensions.
- Mark off lines part 1 and 2 with a vernier height gauge.
- Punch on witness marks and relief hole marks.
- Drill relief holes of ∅ 3 mm in both the parts 1 & 2 and also chain drill in part 2.

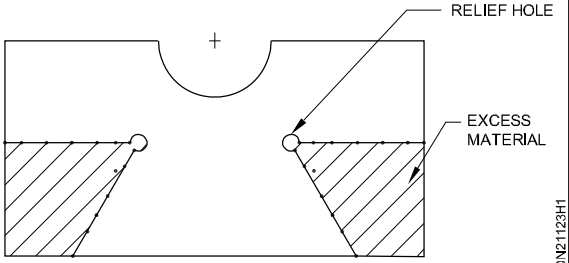
Part - 1

- Hacksaw on sides of dovetail of Part 1 to remove excess metal as shown in Fig 1.

1	75 ISF 10 - 50	–	Fe310	–	2	2.1.123
1	75 ISF 10 - 40	–	Fe310	–	1	2.1.123
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

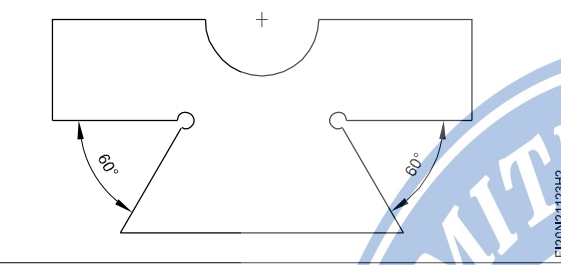
SCALE : 1:1	MAKE DOVETAILED FITTING AND RADIUS FITTING	TOLERANCE : ±0.02 mm	TIME: 18 Hrs
		CODE NO: FI20N21123E1	

Fig 1



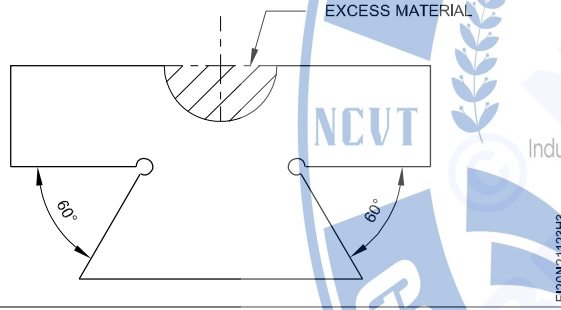
- File and check the size with vernier caliper and anlge with vernier bevel protractor as shown in Fig 2.

Fig 2



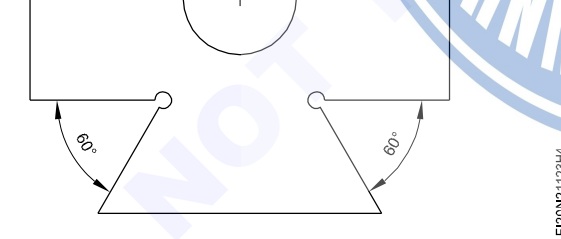
- Similarly, hacksaw on the other side of round profile, remove excess metal to size and shape as shown in Fig 3.

Fig 3



- Remove excess metal using bastard, second cut and smooth file. File half round profile using half round file and check the profile with radius gauge Fig 4.

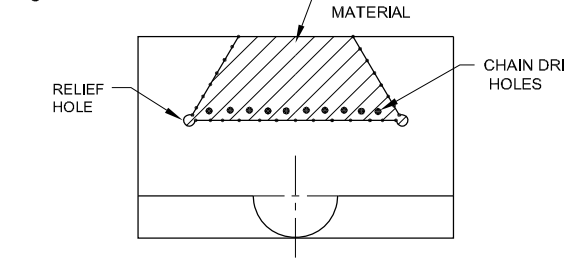
Fig 4



Part - 2

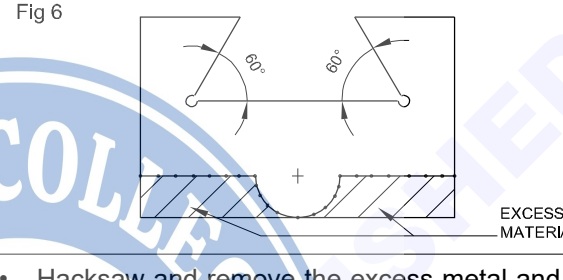
- Hacksaw on sides of dovetail to remove excess metal as shown in Fig 5.
- Chain drill and cut off along the chain drilled holes using web chisel and ball pein hammer and remove as shown in Fig 5.

Fig 5



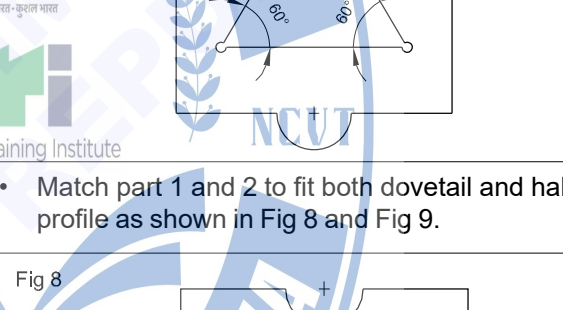
- File the internal dovetail of Part -2 to size and angle and check the size with vernier caliper and angle with vernier bevel protractor Fig 6

Fig 6



- Hacksaw and remove the excess metal and file the half round profile to size and check it with radius gauge Fig 7.

Fig 7



- Match part 1 and 2 to fit both dovetail and half round profile as shown in Fig 8 and Fig 9.

Fig 8

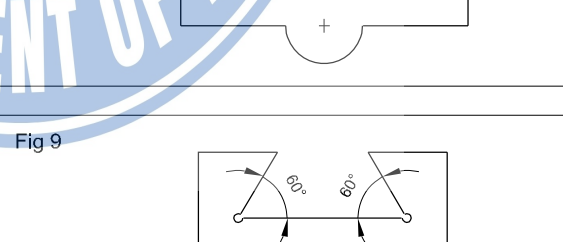
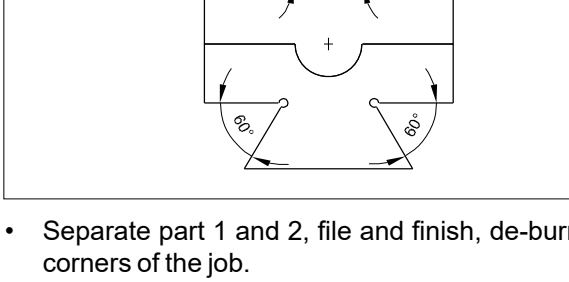


Fig 9

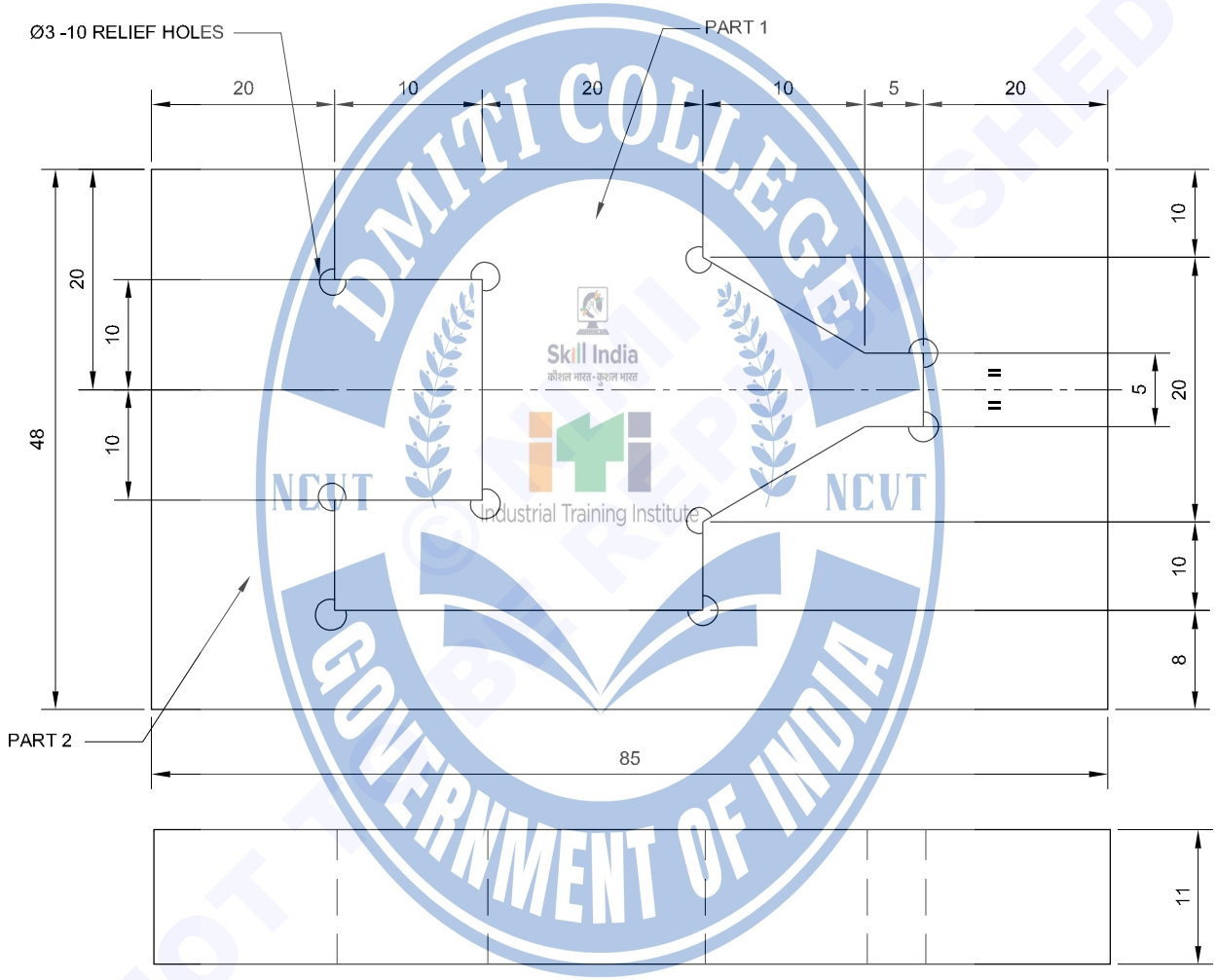


- Separate part 1 and 2, file and finish, de-burr all the corners of the job.
- Apply thin coat of oil and preserve it for evaluation.

File and fit, combined fit with straight, angular surface with ± 0.02 mm accuracy

Objectives: At the end of this exercise you shall be able to

- **file flat and square to accuracy of ± 0.02 mm**
- **mark dimensions with a vernier height gauge**
- **drill relief holes**
- **fit part 1 & 2 maintaining and accuracy of ± 0.02 mm.**



1	50 ISF 12 - 90		Fe310	–	2	2.1.124
1	50 ISF 12 - 45		Fe310	–	1	2.1.124
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

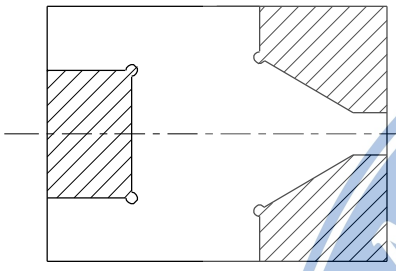
SCALE : NTS	**FILE AND FIT, COMBINED FIT WITH STRAIGHT, ANGULAR SURFACE WITH ± 0.02 mm ACCURACY**	TOLERANCE : ±0.02 mm	TIME: 18 Hrs
		CODE NO: FI20N21124E1	

Job Sequence

- Check the raw material for its size.
- File and finish part 1 & 2 for the overall dimensions.
- Check the size with vernier caliper.
- Mark off dimensional lines in part 1 & 2 with a vernier height gauge.
- Punch on witness marks and relief hole markds.
- Chain drill and drill relief holes of ∅ 3 mm in part 1 & 2 as shown in Fig 1 to 4.

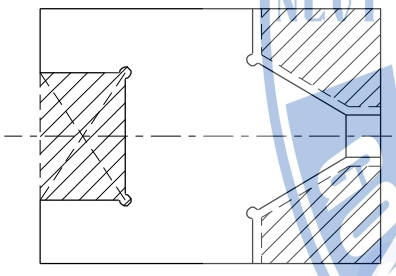
Part 1

Fig 1



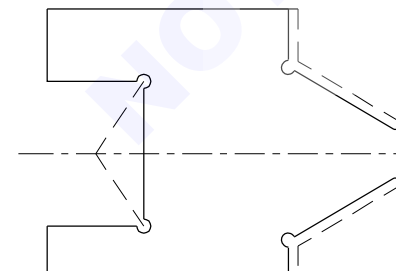
- Hacksaw on one portion of part 1 to remove excess metal and file to size and shape maintaining accuracy of ± 0.02 mm Fig 2.
- Check the size with vernier caliper.

Fig 2



- Similarly, hacksaw on other two portion of part 1 to remove excess metal and file to shape to an accuracy of ± 0.02 mm Fig 3.

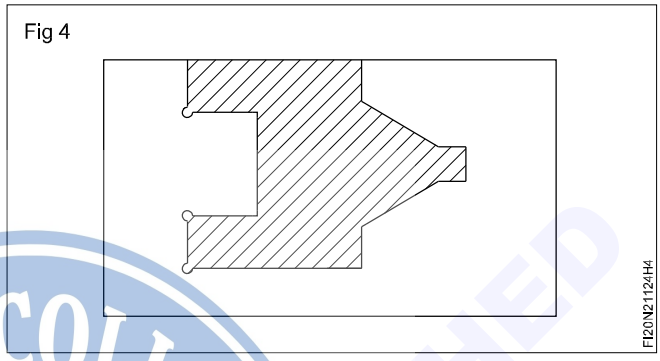
Fig 3



Part 2

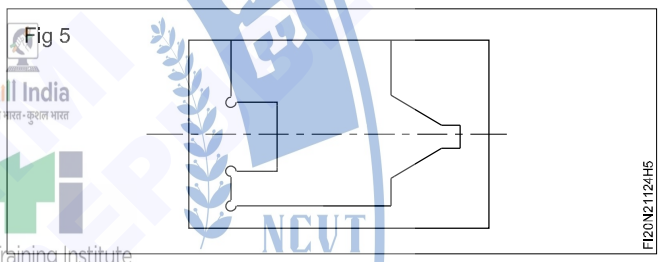
- Chain drill and drill relief holes ∅ 3mm as shown in Fig 4.
- Hacksaw, chip and remove the excess material as shown in Fig 4.

Fig 4



- File to size to shape maintaining accuracy of ± 0.02 mm.
- Check the size with vernier caliper.

Fig 5

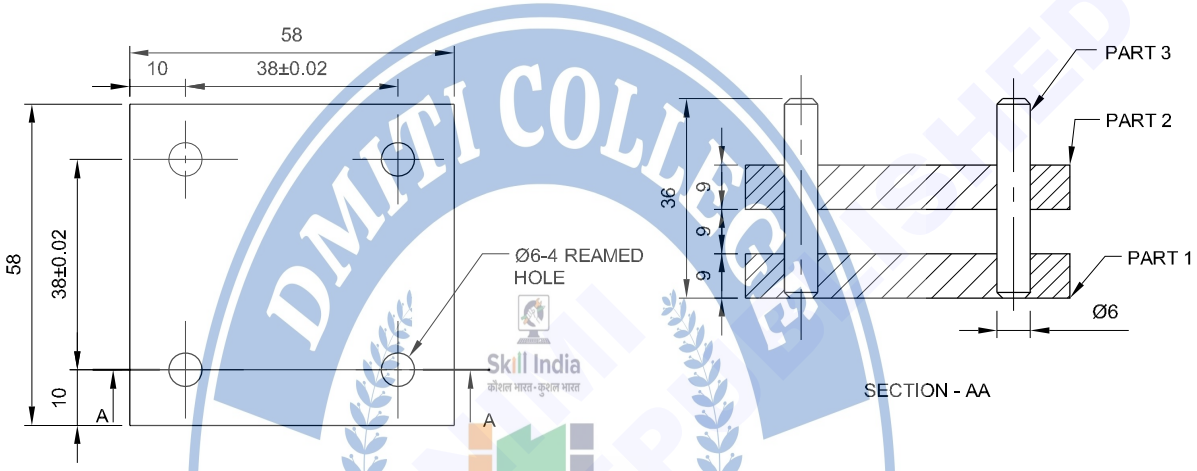


- Finish file part 1 and deburr in all corners of the job.
- Fit part 1 and 2 as shown in job drawing.
- Apply thin coat of oil and preserve it for evaluation.
- Clean and arrange the tools in order.

Drilling and reaming small dia. holes to accuracy & correct location for fitting

Objectives: At the end of this exercise you shall be able to

- **file surfaces flat and parallel to an accuracy of ± 0.02 mm**
- **mark off dimensions with a vernier height gauge**
- **measure dimensions with a vernier caliper**
- **drill through holes as per drawing**
- **ream the holes and assemble with dowel pins.**



Job Sequence

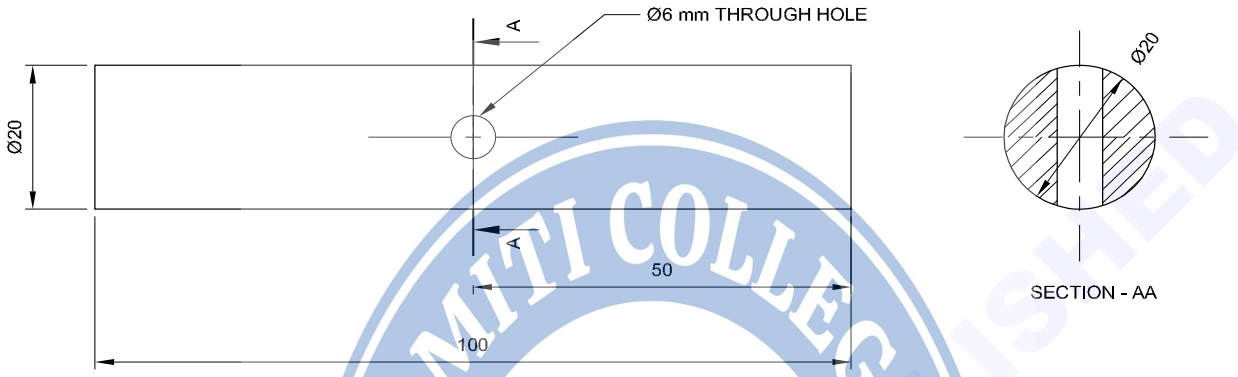
- Check the raw material for its size.
- File one flat surface and two adjacent sides at right angles to each other on both pieces.
- Apply marking media on the surfaces of the job.
- Mark the dimensions and the hole location with a vernier height gauge.
- Punch the witness mark using dot punch.
- Punch the hole location using centre punch.
- Remove excess material by hacksawing and file to size 58x58x9mm on both the pieces.
- Measure the dimensions with a vernier caliper
- Clamp both pieces together on the drilling machine vice and keeping parallel blocks under the job.
- (Use parallel clamps for holding both jobs)
- Using a centre drill locate the hole position and drill up to 1mm depth.
- Without changing the position of the job remove the centre drill and fix a ∅ 5.8 mm drill and drill a through hole.
- Similarly drill the other three holes.
- Remove the job from the drilling machine and ream the holes using ∅ 6 mm hand reamer by holding in a vice.
- Fix the 4 dowel pins in reamed holes.
- Check the squareness of dowel pins & correct location.
- Apply little oil and preserve it for evaluation.

4	Ø6 - 36	DOWEL PIN	AS PER IS 6689	–	3	2.1.125
2	65 ISF 10 - 60	MATCH PLATE	Fe310	–	1 & 2	2.1.125
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : 1:1	DRILLING AND REAMING SMALLER DIA. HOLES TO ACCURACY & CORRECT LOCATION FOR FITTING	TOLERANCE : ±0.02 mm	TIME: 4Hrs
		CODE NO: FI20N21125E1	

Perform drilling using 'V' Block and a clamp

Objectives: At the end of this exercise you shall be able to
- **set cylindrical job on 'V' block**
- **drill on cylindrical job.**

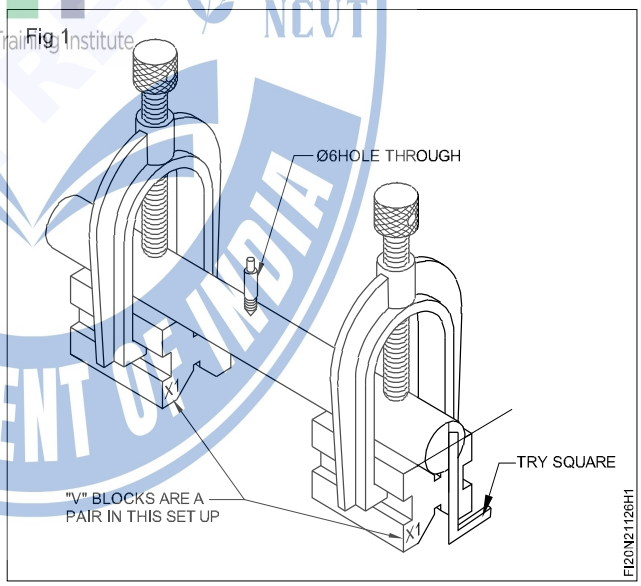


Job Sequence

- Place two 'V' blocks on the marking table.
- Keep the pre machined cylindrical job on 'V' block.
- Insert 'U' clamps in the 'V' block and clamp it.
- Mark the centre line at both periphery and face using vernier height gauge.
- Punch the location of hole as per drawing.
- Align the centre line on face of round rod perpendicular to the drilling machine table surface.
- Clamp the job rigidly.
- Set the proper Rpm.
- Using centre drill locate the hole position and drill up to 1mm depths
- Drill ∅ 6 mm to through hole.
- Loosen the 'U' clamp and remove the job from 'V' block.

Use two 'V' blocks and clamp to support long round rods rigidly while marking. (Fig -1)

Fig 1



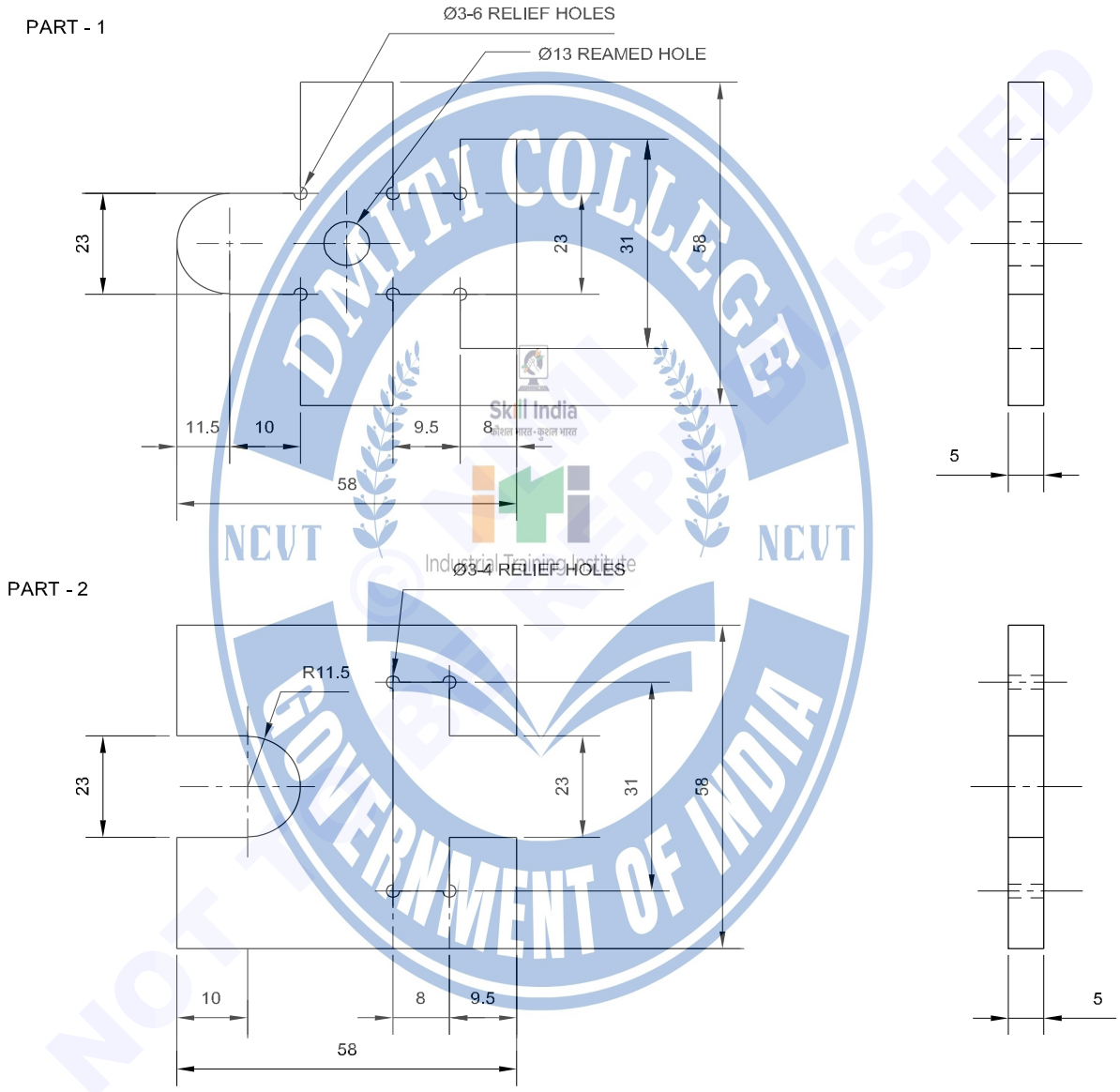
1	Ø20 - 100	-	Fe310	–	1	2.1.126
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : 1:1	PERFORM DRILLING USING "V" BLOCK AND "U" CLAMP	TOLERANCE : ±0.02 mm	TIME: 1Hr
		CODE NO: FI20N21126E1	

Make male and female fitting parts, drill and ream holes

Objectives: At the end of this exercise you shall be able to

- **file and finish the job to the over all dimensions**
- **mark and punch all dimensions**
- **drill and ream the hole**
- **file and finish Part 1 and part 2 and match it.**



2	60 ISF 6 - 60	-	Fe310	-	PART 1 & 2	2.1.127
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	MAKE MALE AND FEMALE FITTING PARTS				TOLERANCE : ±0.02 mm	TIME: 18 Hrs
					CODE NO. FI20N21127E1	

Job Sequence

- Check the raw materials for its size.

Part 1

- File Part 1 to overall size 58 x 58 x 5 mm and check the sizes with Vernier caliper
- Check flatness and squareness with try square.
- Apply marking media and make lines as per drawing
- Punch witness marks and drill hole marks.
- Drill relief holes in drilling machine
- Drill ∅ 12.7 mm through hole for reaming.
- Ream ∅ 13 mm hole with reamer.
- Cut and remove excess materials and file the profile of the job maintaining necessary accuracy of ±0.02 mm.
- Check the size with the vernier caliper.
- Check the radius with radius gauge.
- Check the 9.5 mm slots using with vernier caliper.
- Finish all the surfaces and de burr, corners of the job.

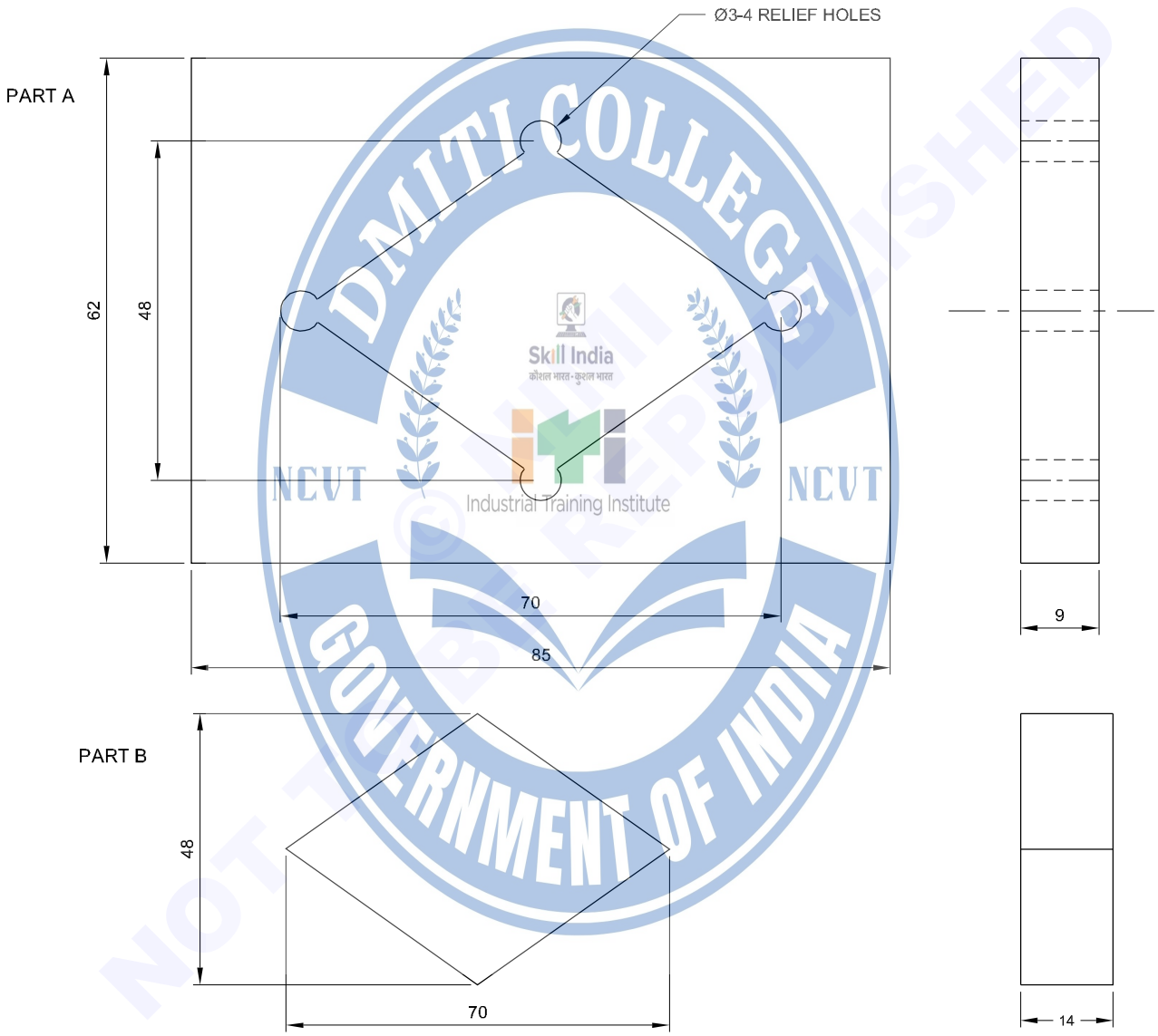
Part 2

- Similarly repeat the above job sequence for part 2 and file the profile of the job.
- Remove unwanted material by chain drilling, hacksawing and chipping.
- Match part 1 and part 2 as per job drawing
- Apply thin oil and preserve it for evaluation.

Make sliding diamond fitting

Objectives: At the end of this exercise you shall be able to

- **file flat surfaces and parallel to an accuracy of ± 0.02 mm**
- **file angular surfaces to an accuracy of ± 15‘**
- **relief drill hole of ∅ 3 mm**
- **chain drill hole and remove excess metal**
- **file to size and match as per drawing**
- **finish and deburr.**



1	50 ISF 16-75	-	Fe310	-	B	2.1.128
1	65 ISF 10-90	-	Fe310	-	A	2.1.128
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE: NTS	MAKE SLIDING DIAMOND FITTING				TOLERANCE : ±0.02 mm	TIME 22 Hrs
					CODE NO. FI20N21128E1	

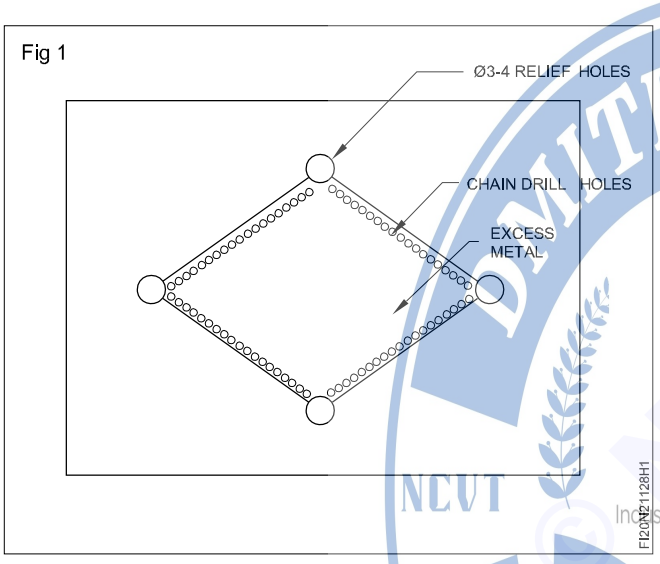
Job Sequence

- Check the raw material for its size.
- File and finish part A and part B for the over all size maintaining parallelism and perpendicularity.
- Mark of part A and part B with a vernier height gauge as per drawing.
- Punch witness marks and relief hole marks.
- Drill relief holes of ∅ 3mm in part A.
- Chain drill hole in part A.

Part A

- Chip and remove excess metal in part A as shown in Fig 1.

Fig 1

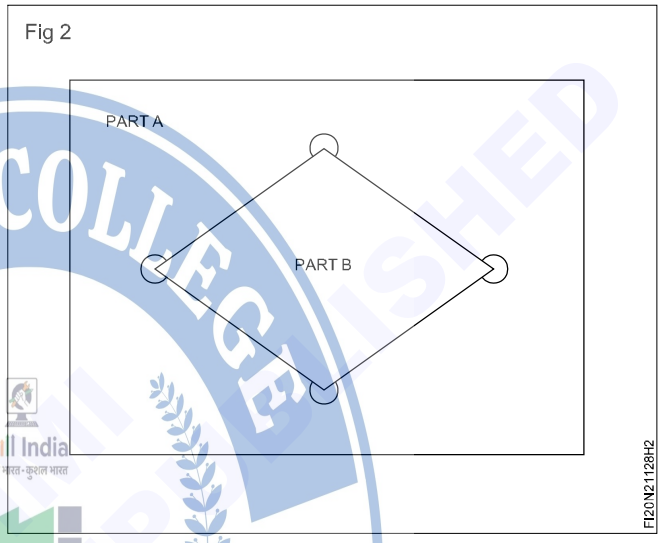


- File part A to size and shape as per drawing.
- Check the size with vernier caliper and angles with vernier level protractor.

Part B

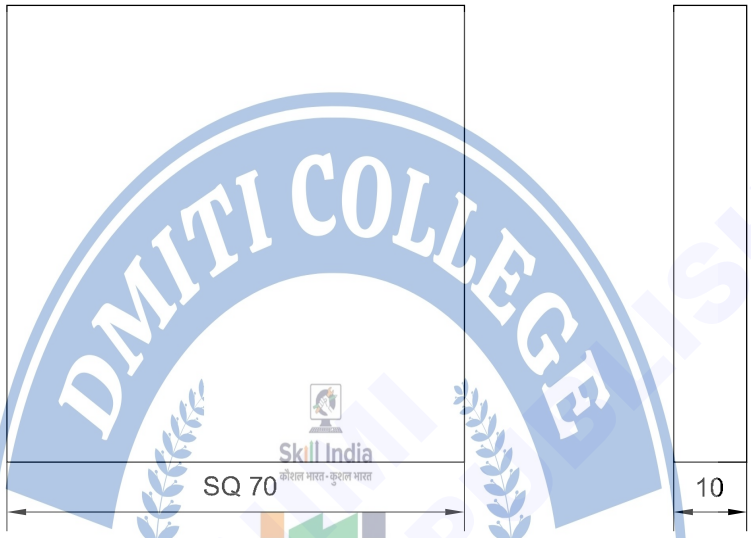
- File part B to size and shape as per drawing.
- Match part A and B as shown in Fig 2.
- Finish part A and B and remove burrs in all corners.
- Apply a thin coat of oil and preserve it for evaluation..

Fig 2



Lap flat surfaces using lapping plate

Objectives: At the end of this exercise you shall be able to
- **lap the surface using lapping plate**
- **smear the lapping medium**
- **check the surface quality with surface roughness standard set.**



Job Sequence

- Check the raw material size.
- Cut the material as per size given in the drawing.
- Mark the job as per dimension given in the drawing.
- Punch on the marked line and cut the unwanted materials.
- File and finish to the size.
- Place the lapping plate on the bench vice.

Make sure the lapping plate not shacking.

- Position the job on the lapping plate.
- Apply lapping medium.
- Hold the job tightly and lap the surface.
- Checking the flatness by applying prussian blue method.
- Finish the job accurately.

Precautions:
- Always keep the lap moist.
- While lapping use the entire surface of the lapping plate.
- Do not give any excessive pressure.
- Check the surface roughness by comparing with standard set of roughness sample.

1	75 ISF 12 x 75	-	Fe310	-	-	2.1.129
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	LAP FLAT SURFACES USING LAPPING PLATE				TOLERANCE: ±0.02 mm	TIME: 5hrs
					CODE NO. FIN20N21129E1	

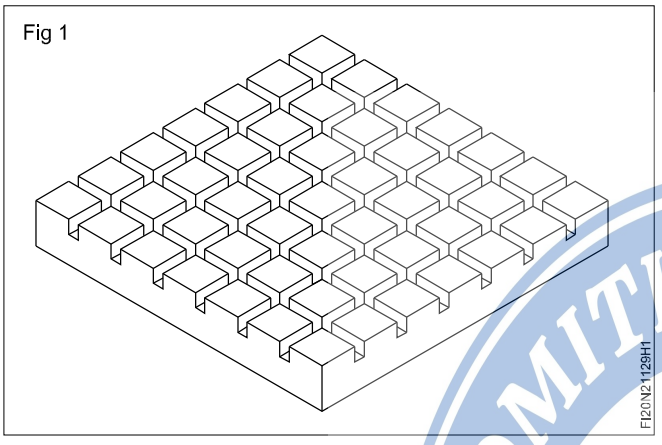
Skill Sequence

Lapping flat surfaces

Objective: This shall help you to
- **lap flat surfaces using a lapping plate.**

For lapping flat surfaces, a rigid cast iron plate - machined perfectly flat with grooves cut on it (Fig 1) can be used as a lapping plate.

Fig 1



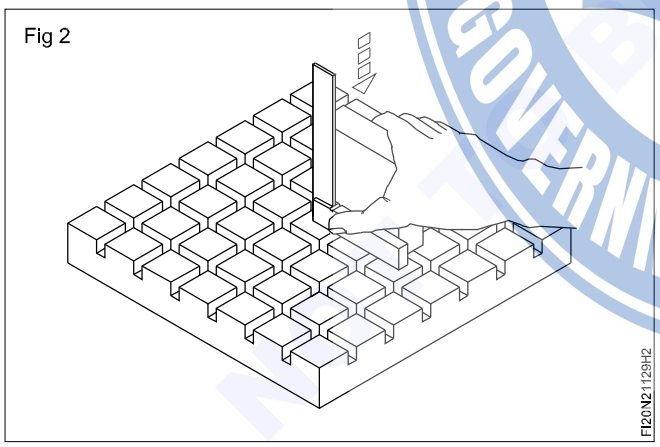
This lapping plate should be kept flat without any rocking on the workbench.

Aluminium oxide may be used as a lapping medium as the workpiece is unhardened steel.

Smear the lapping medium on the plate and charge that surface.

The section of the workpiece being very thin, use a machined and ground cast iron block to butt against the workpiece while lapping. This will assist to keep the workpiece perpendicular while lapping. (Fig 2)

Fig 2

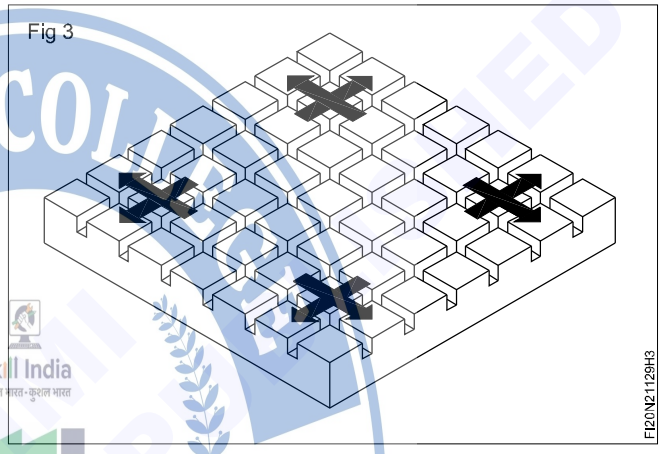


The method of holding the workpiece should be such that it moves along the lapping plate without any tilting or rocking.

Apply downward pressure with finger tips while moving the work.

Use the entire surface of the lapping plate while lapping (Fig 3) to avoid wear on the plate in different small areas.

Fig 3



Do not dwell in one place while lapping.

The lapped surface can be identified by the dull surface. Lapping should be continued until the entire surface being lapped has a dull appearance.

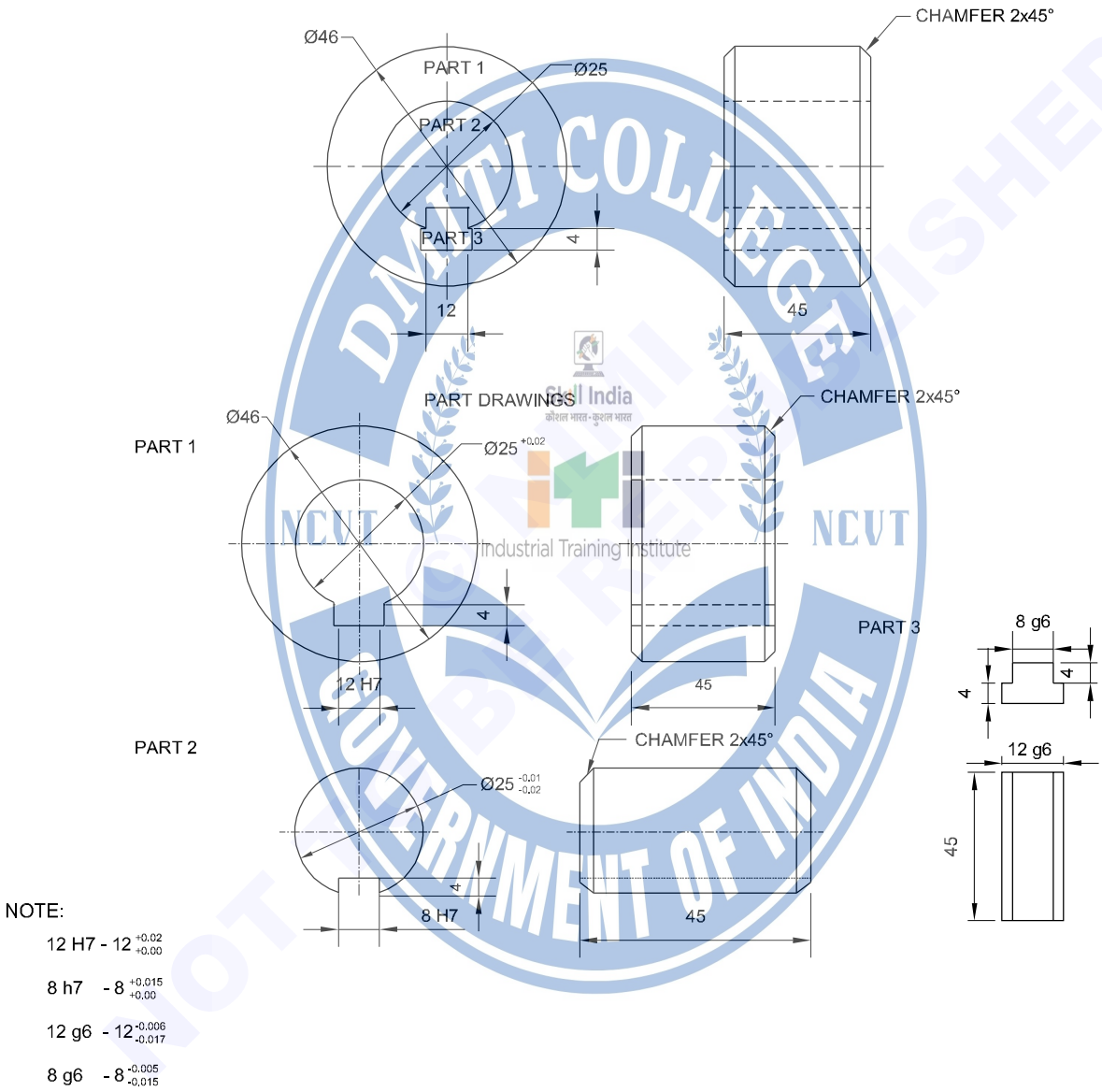
When the entire surface is lapped, clean the surface with kerosene and inspect the workpiece.

The surface texture of the surface being lapped should show a dull appearance.

Prepare stepped keyed fitting and test job

Objectives: At the end of this exercise you shall be able to

- **file surfaces to flat and square to an accuracy of ± 0.02 mm**
- **mark dimension lines as per drawing using vernier height gauge**
- **prepare hub, shaft and stepped key as per drawing**
- **fit as per drawing**
- **finish and de-burr.**



1	Ø50 - 50	HUB	Fe310		1	2.1.130
1	Ø28 - 50	SHAFT	Fe310		2	2.1.130
1	16 ISF 10-50	STEPPED KEY	Fe310	-	3	2.1.130
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	**PREPARE STEPPED KEYED FITTING ANDTEST JOB**				TOLERANCE : ±0.02 mm	TIME :16Hrs
					CODE NO: FI20N21130E1	

Job Sequence

- Check the raw material using steel rule.
- File and prepare part 1, 2 and 3 for the over all size maintaining parallelism and perpendicularity.
- Mark off part 1, 2 and 3 with vernier height gauge as per drawing.
- Punch witness marks.

Part 1

- Hold the job in four jaw chuck in lathe.
- Turn face turning on ends.
- Turn ∅ 46 x 45 mm length.
- Chamfer the outer end of the job 2 mm x 45°.
- Centre drill to locate the centre of the job.
- Fix ∅ 6 mm twist drill in tail stock through drill chuck and drill pilot hole.
- Drill and bore ∅ $25^{+0.02}$ mm through hole.
- Chamfer the ∅ 25 mm hole end to 2 mm x 45°.
- Reverse the job and hold it in lathe chuck.
- Plain turn the job to ∅ 46 mm.
- Face turn the other end and also maintain the length as per drawing.
- Chamfer outer and inner end of the job to 2 mm into 45° as per drawing.
- Mark and file keyway in part 1 as shown in drawing.
- Check the keyway size using vernier caliper.

Part 2

- Hold the job in four jaw chuck in lathe.
- Turn face turning on ends.
- Chamfer the end to 2 mm x 45°.
- Plain turn the job of ∅ $25^{-0.02}_{-0.01}$ mm to the maximum length.
- Reverse the job and hold it in lathe chuck.
- Face turn the other end of the job keeping the required length as per drawing.
- Chamfer the end to 2 mm x 45°.
- Mark and file the key way on shaft as per drawing dimension.
- Check the key way size with vernier caliper.

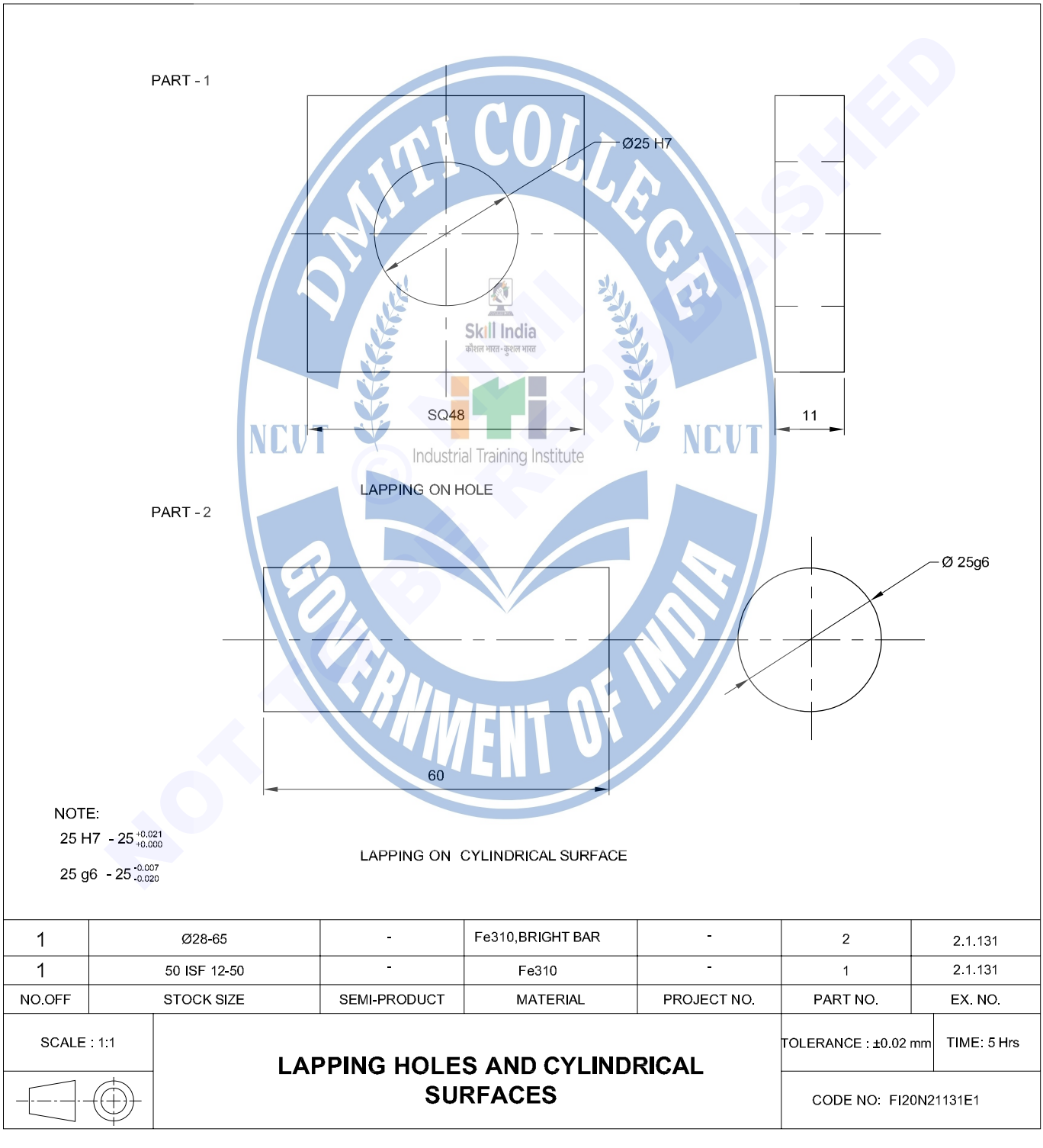
Part 3

- Mark the dimensional lines and punch witness marks in part 3 as per drawing.
- Hacksaw and remove the excess metal and file it to size and shape as per drawing.
- Finish file and remove burrs in all the corners of the stepped key.
- Assemble part 1 and 2 together and fit stepped key into the keyway slot as shown in drawing.
- Apply a little oil and preserve it for evaluation.

Lapping holes and cylindrical surfaces

Objectives: At the end of this exercise you shall be able to

- **lap hole (internal)**
- **lap shaft (external)**
- **change the abrasive compound on laps**
- **check the hole size with three point internal micrometer**
- **check the shaft with vernier micrometer**
- **match shaft and hole together.**



1	Ø28-65	-	Fe310,BRIGHT BAR	-	2	2.1.131
1	50 ISF 12-50	-	Fe310	-	1	2.1.131
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : 1:1	**LAPPING HOLES AND CYLINDRICAL SURFACES**	TOLERANCE : ±0.02 mm	TIME: 5 Hrs
		CODE NO: FI20N21131E1	

Job Sequence

- Prepare the bore in part 1 as per drawing.
- Hold the job in bench vice.
- Select a adjustable cylindrical lap for lapping hole
- Charge the abrasive compound (lapping compound) on cylindrical lap
- Insert the adjustable cylindrical lap in a cylindrical hole.
- Rotate the lap forward key pushing inside hole giving a clock wise movement.

Never remove the lap while lapping.

- While removing the lap from the job, hold and rotate it in clock wise direction and take out.
- Clean the lapping hole with kerosene and wipe with soft cloth.
- Check the hole size using three point internal micrometer.
- Lapping external cylindrical surface (shaft) manual process.
- Prepare the shaft as per drawing.
- Hold the job in bench vice/lathe.
- Select a adjustable ring lap.
- Charge the abrasive compound in adjustable ring lap.
- Insert the abrasive ring lap on cylindrical surface.
- Rotate and slide the ring lap forward and backward along the cylindrical surface.
- Apply light pressure while lapping.
- Clean the lapped cylindrical surface with kerosene and wipe with soft cloth.
- Check the shaft size using vernier micrometer.
- Match shaft with hole.
- Apply thin coat of oil and preserve it for evaluation.

Skill Sequence

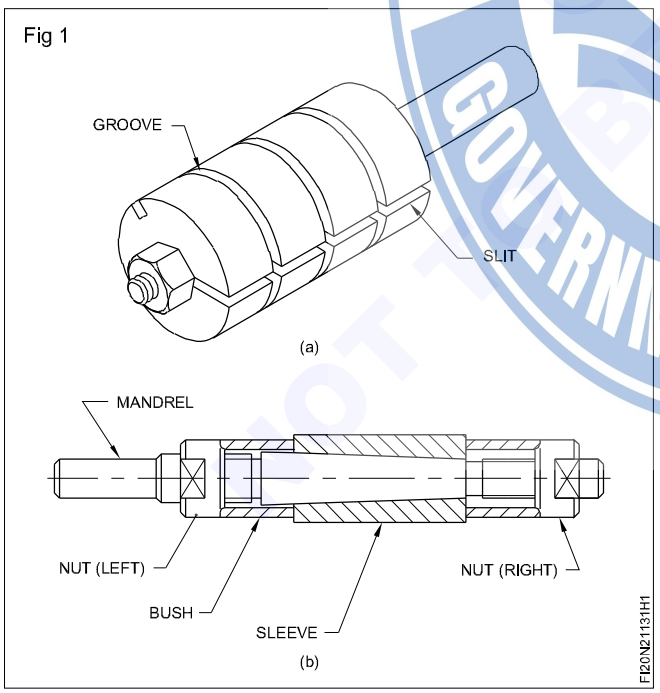
Lapping holes and cylindrical surfaces

Objective: This shall help you to

- **lap on internal and external cylindrical surfaces.**

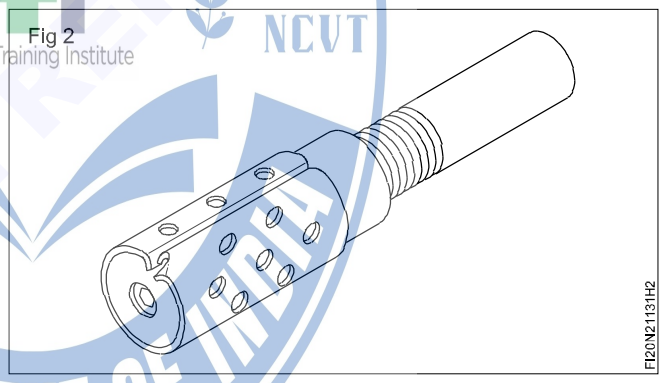
Solid or adjustable types of laps are used for lapping internal cylindrical surfaces/holes (Fig.1). Adjustble lap have interchangeable sleeves made of copper.

Fig 1



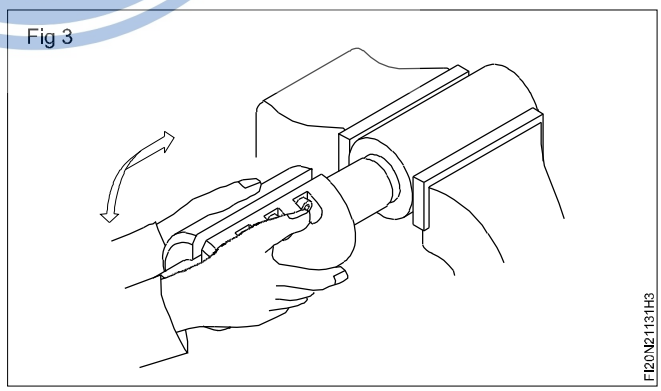
Laps are sometimes provided with holes which can hold the lapping compound (Fig.2).

Fig 2



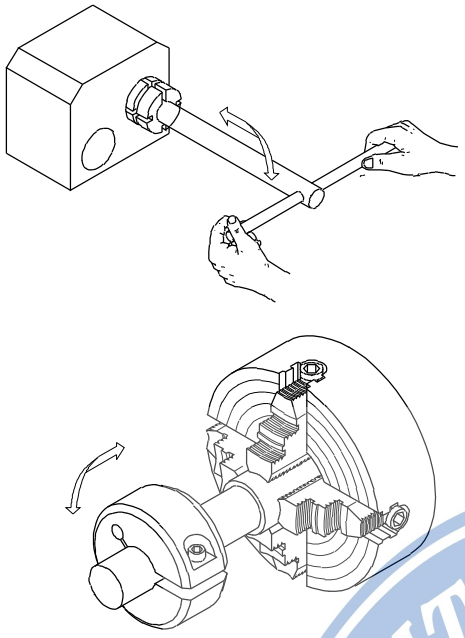
Ring lapping can be done manually Fig 3 or by holding the work on the lathe while the split ring is moved over the cylindrical surface.

Fig 3



The lap should not be removed from the hole while lapping, and should travel the full length of the bore Fig 4.

Fig 4

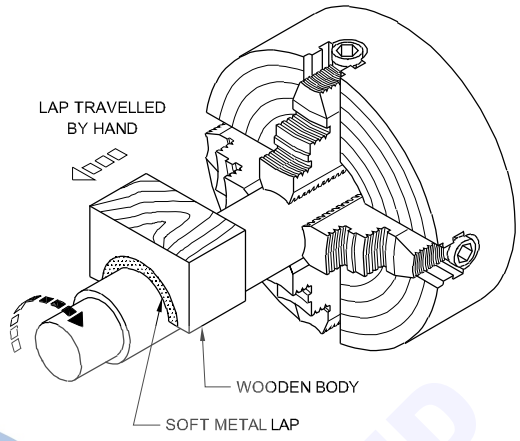


FI20N21131H4

While lapping, the ring lap should slide forward and backward along the workpiece - rotating the lap at the same time in alternate directions.

For lapping large diameters, special laps can be prepared and used Fig 5.

Fig 5



FI20N21131H5

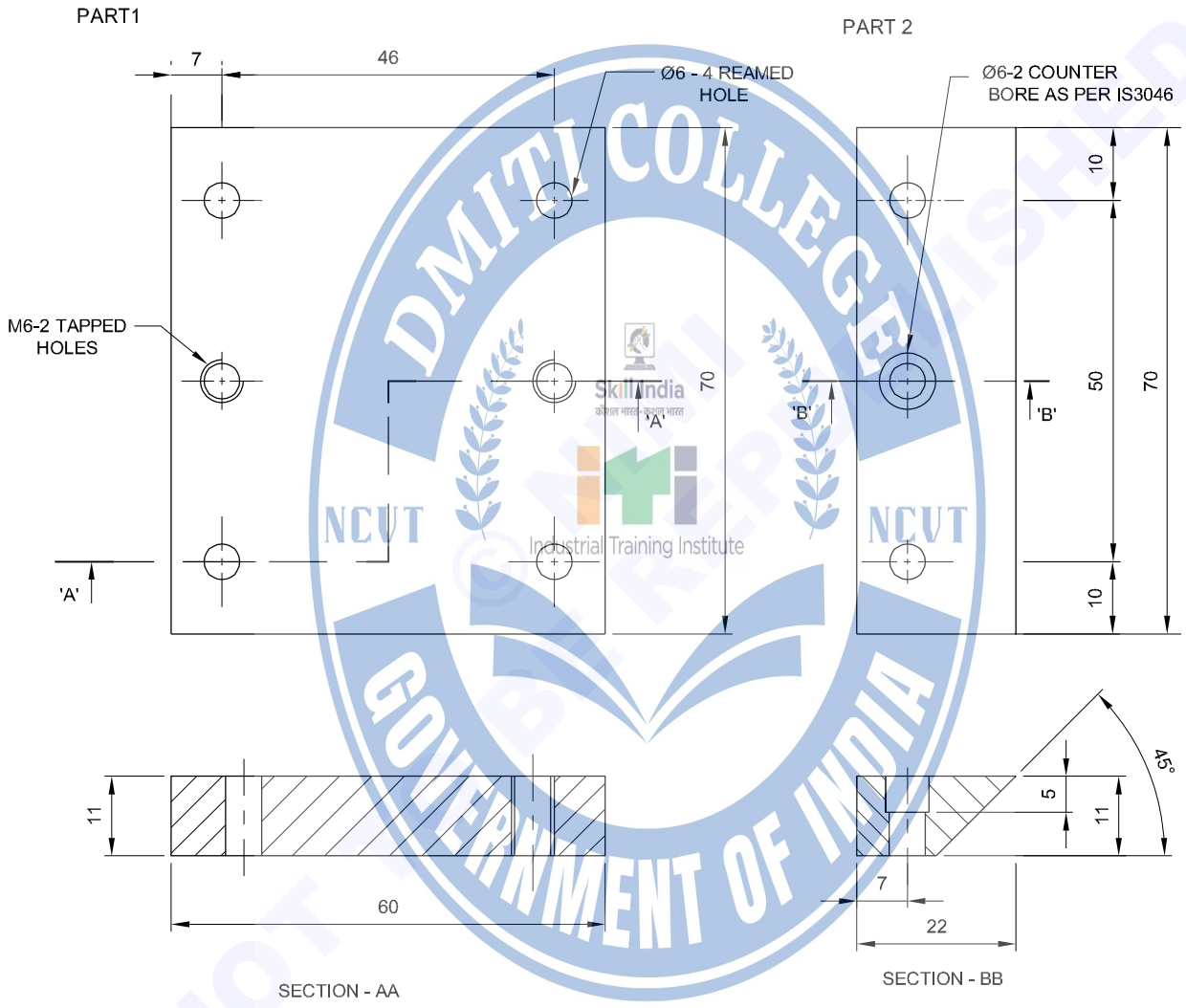
Precautions to observed while lapping:

- Do not dwell in the same place while lapping.
- Keep the lap moist always.
- Do not add fresh abrasive during lapping; recharge if necessary.
- Do not apply excessive pressure while lapping.

Dovetail and dowel pin assembly

Objectives: At the end of this exercise you shall be able to

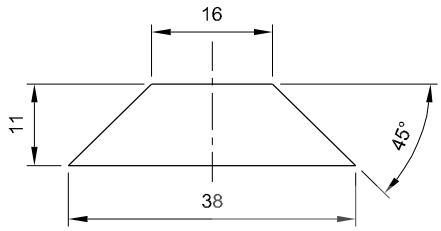
- **file part 1,2,3 to size**
- **drill, ream & tap at correct location**
- **counter bore to required depth**
- **assemble Part 1,2 3 with dowel pins and cheese head screws.**



2	M6 X 16 mm LENGTH	CHEESE HEAD SCREW	-	–	5	2.1.132
4	Ø6 - 22	DOWEL	-	–	4	2.1.132
1	75 ISF12 - 40	SLIDE	Fe310	–	3	2.1.132
2	75 ISF 12 - 30	TOP PLATE	Fe310	–	2	2.1.132
1	65 ISF 12 - 75	BASE PLATE	Fe310	–	1	2.1.132
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : 1:1	**DOVETAIL AND DOWEL PIN ASSEMBLY**	TOLERANCE : ±0.02mm	TIME: 16 Hrs
		CODE NO: FI20N21132E1	

PART 3



ASSEMBLY

-	-	-	-	–	-	2.1.132
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE :1:1	**DOVETAIL AND DOWEL PIN ASSEMBLY**				TOLERANCE :	TIME:
					CODE NO: FI20N21132E2	

Job Sequence

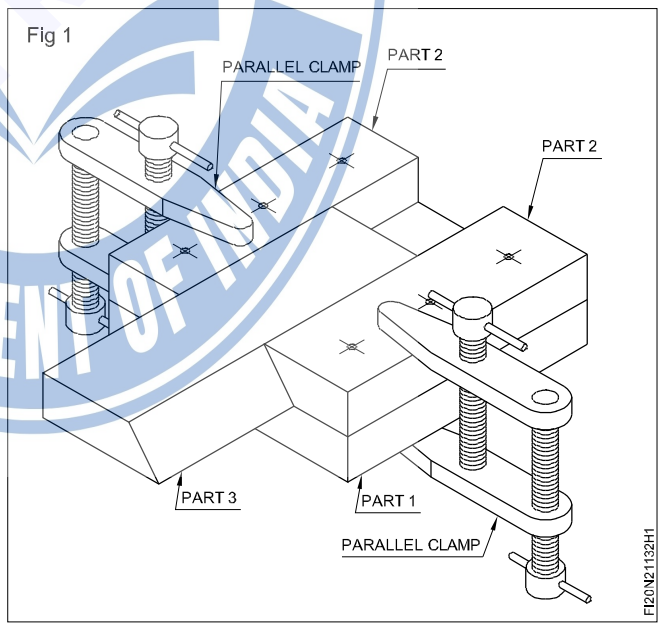
- Check the raw material for its size.
- File part 1,2, and 3 for its overall dimensions
- Mark the dimensions and location of holes as per drawing on part 1 and 2 by using vernier height gauge.
- Centre punch on the location of holes in part 1 & 2 and punch the witness marks.
- File part 2 and 3 to the required angle and check it with vernier bevel protractor to an accuracy ± 10 minute.
- Set all four pieces together and clamp them with parallel jaw clamps and check the squareness by using try square.
- Hold all four pieces together with clamps on a drilling machine table.
- Centre drill on part – 2 in both the pieces.
- Remove the centre drill from the drill chuck and fix ∅ 5.8 mm drill in drilling machine and drill through hole.
- Ream ∅ 6 mm in the drilled hole without disturbing the position of job.
- Fix ∅ 6 mm dowel pin in the reamed hole.
- Similarly, drill, ream and fix ∅ 6 mm other three dowel pins as shown in job drawing.
- Fix ∅ 5 mm drill in drilling machine spindle and drill two through holes in the place of cheese head screws assembly to cut M6 internal thread.
- Disassemble and separate all the parts.
- Fix counter bore tool and counter bore to the required depth in part 2 to fix cheese head screws.
- Fix counter sink tool and chamfer in both ends of part 1 for tapping hole to cut internal thread.
- Hold part 1 in bench vice and cut M6 internal thread to fix cheese head screws.
- Clean the threads without burrs.
- Finish file in all the parts and de-burr in all corners of the job.
- Reassemble all the parts as shown in job drawing and slide part 3 in the dovetail slot.
- Apply a little oil and preserve it for evaluation.

Skill Sequence

Objective: This shall help you to
- **assemble the parts for positioning and drilling.**

- Assembling technique by using clamps (Fig: 1)
- Clamp all the parts together using parallel clamps.
- Check the squareness of assembly using trysquare.
- Hold the assembly in drilling machine table without disturbing the setting.

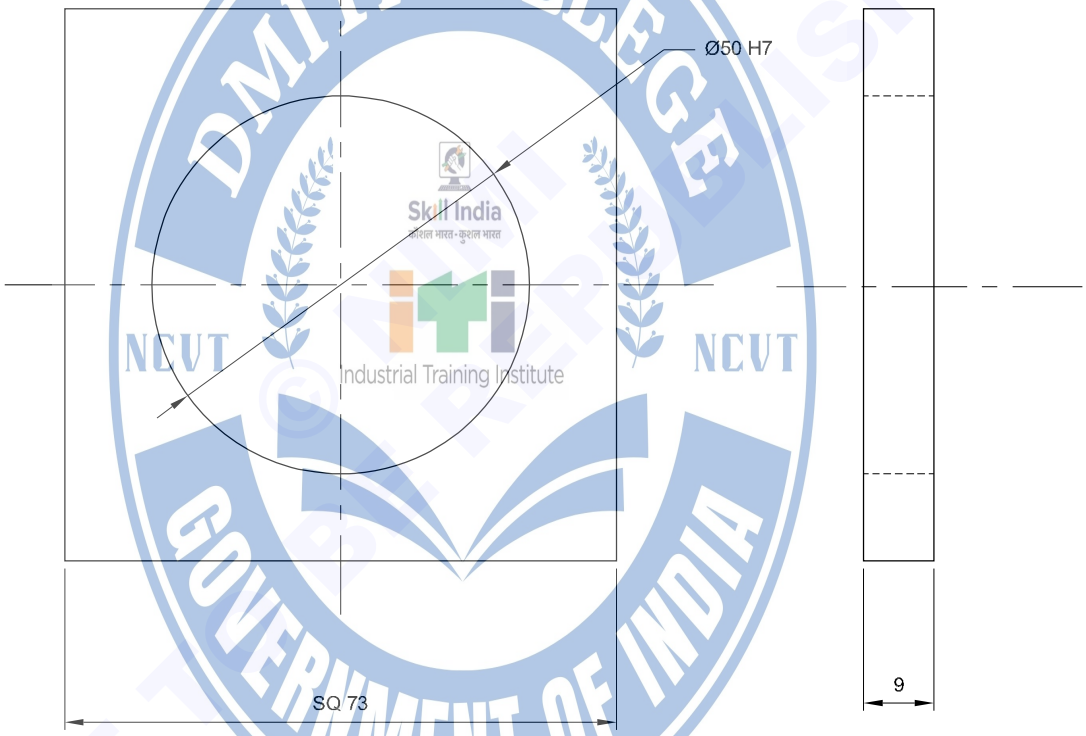
Fig 1



Scrape cylindrical bore

Objectives: At the end of this exercise you shall be able to

- **locate and drill pilot hole**
- **enlarge the pilot hole to size**
- **ream the hole and find high spots**
- **scrape and test the cylindrical hole.**



NOTE:

50 H7 - $50^{+0.025}_{+0.000}$

1	75 ISF 10 x 75mm	→ 2.1.134	Fe310	–	1	2.1.133
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : 1:1	SCRAPE CYLINDRICAL BORE				TOLERANCE : ±0.02mm	TIME: 5Hrs
					CODE NO: FI20N21133E1	

Job Sequence

- Cut the raw material to its size.
- File to size 73 x 73 x 9 mm and check with venier caliper.
- Check the flatness and squareness with try square.
- Mark and punch the centre.
- Drill the pilot hole ∅ 6 mm
- Enlarge a hole ∅ 12, ∅ 25, ∅ 40 and ∅ 49 in sequence.
- Ream the hole ∅ 50 mm using reamer.
- Hold the ∅ 50 mm cylindrical test bar in a bench vice
- Apply prussion blue on cylindrical surface of a test bar ∅ 50 mm
- Insert the reamed hole on cylindrical surface turn clock wise and anti clock wise direction and move it to find high spots.
- Hold the job in bench vice
- Scrape high spots by using half round scraper.
- Clean the scraped surface with soft cloth.
- Check the bore by using three point internal micrometer.
- Check the scraped hole by inside micrometer.
- Again insert the scraped hole on prussian blue applied cylindrical surface of test bar and check for uniform spreading of prussian blue on cylindrical surface of scraped hole.
- Apply thin oil and preserve it for evaluation.

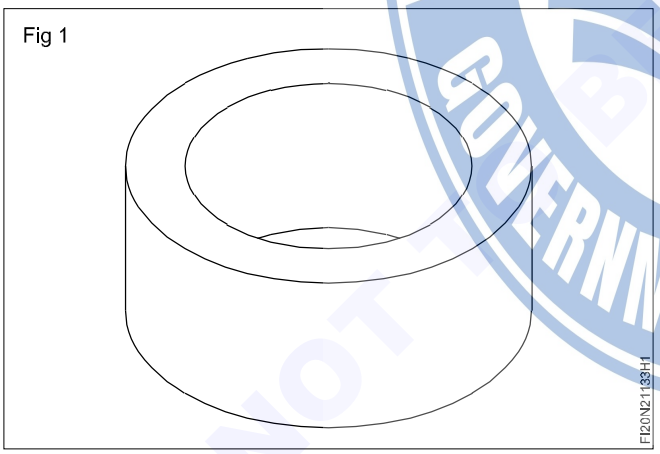
Skill Sequence

Measure diameter using three point internal micro meter

Objectives: This shall help you to
- **skill information is required for 3 point micrometer**
- **measure diameter of through holes**
- **check cylindricity and roundness of bore using three point internal micrometer.**

- Select the correct size of three point internal micro meter.
- Select the proper zero setting ring Fig 1.

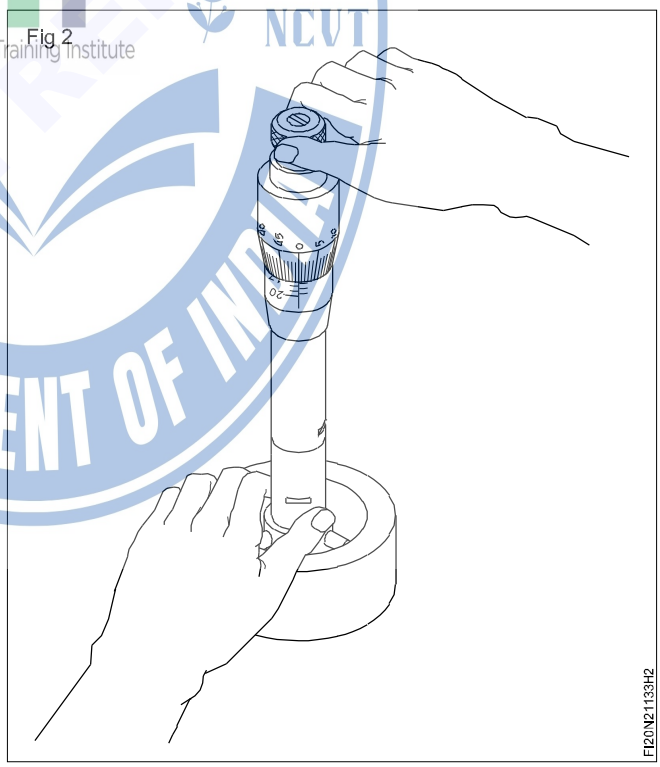
Fig 1



Before taking the measurements.

- Set the zero in three point internal micrometer using zero setting ring Fig 2.
- Check the measurement of job bore size using three point internal micrometer.

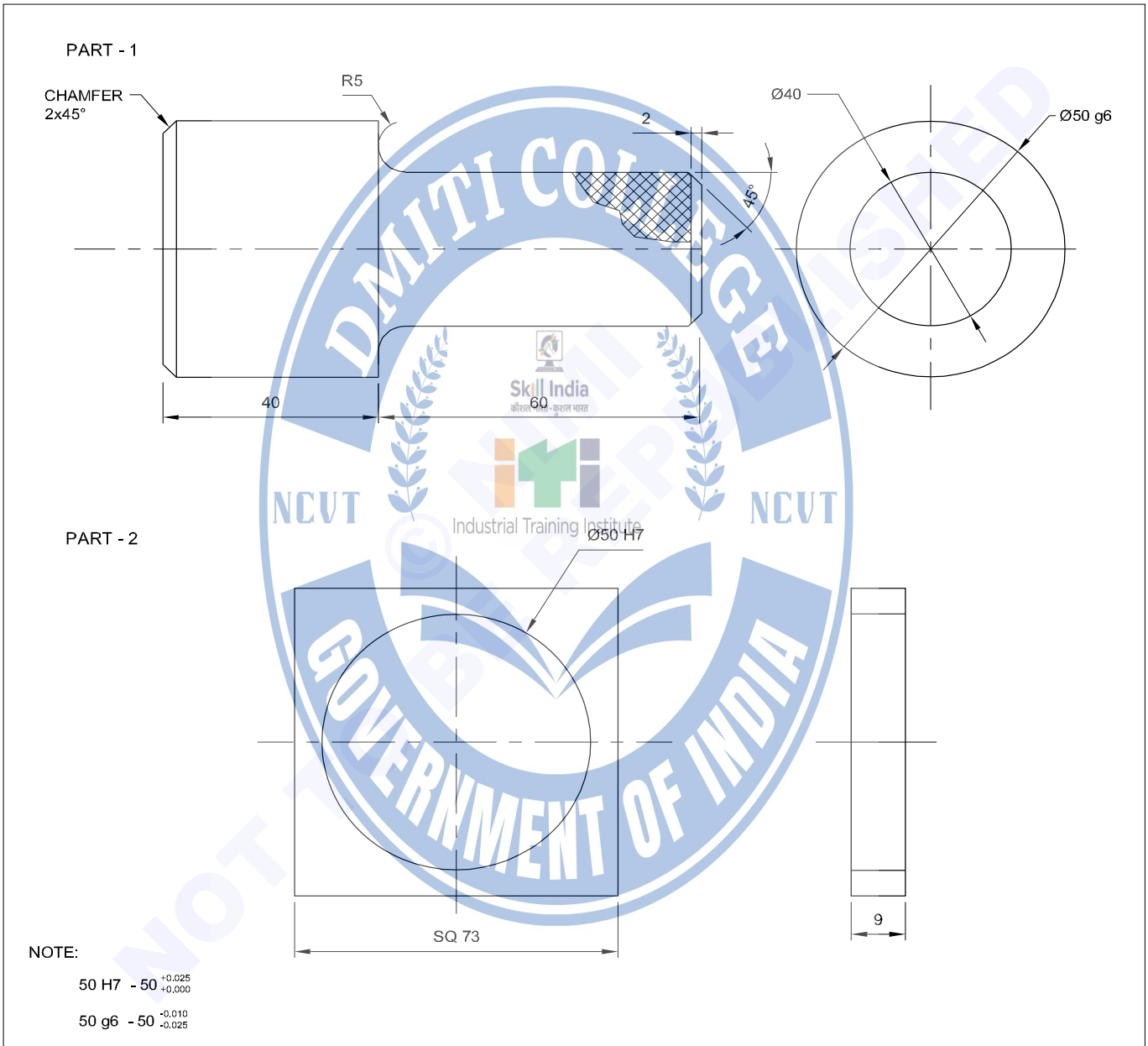
Fig 2



Scrapping cylindrical bore and to make a fit

Objectives: At the end of this exercise you shall be able to

- **turn the shaft as per dimensions in Part 1**
- **drill the hole dia 49.50 mm on part 2**
- **ream cylindrical bore to Ø 50**
- **scrape on cylinder bore**
- **check the scrapped bore with plug gauge.**



1	–	2.1.133 ←	Fe310	–	2	2.1.134
1	Ø56 - 105		Fe310	–	1	2.1.134
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : 1:1	SCRAPPING CYLINDRICAL BORE AND TO MAKE A FIT				TOLERANCE : ±0.02mm	TIME: 12 Hrs
					CODE NO: FI20N21134E1	

Job Sequence

Part: 1

- Cut the raw material to its size.
- Turn the shaft as per dimension in lathe.
- Turn shouldering and knurl in the shaft job as per the drawing.
- Finish the shaft within the dimensions.
- (Part – 1 making correct size ∅ 50 g6 as a master gauge for checking scraped hole)

Part: 2

- Use Ex No 133 workpiece as part 2
- Clean the scraped surface with soft cloth
- Fit the master test piece into the scraped hole and rotate smoothly for testing.
- Note that the master piece should rotate freely.
- Apply a little oil and preserve it for evoluation.

Skill Sequence

Objective: This shall help you to

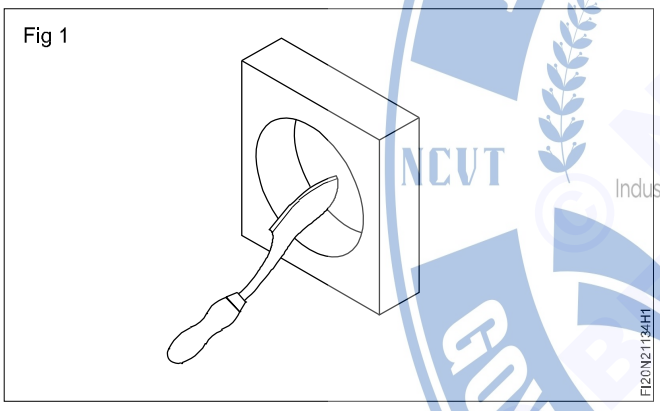
- **scraping and testing of curved surface.**

A half round scraper is the most suitable scraper for scraping curved surfaces. This method of scraping differs from that of flat scraping.

Method

For scraping curved surfaces the handle is held by hand in such a way as to facilities the movement of the scraper in the required direction Fig 1.

Fig 1



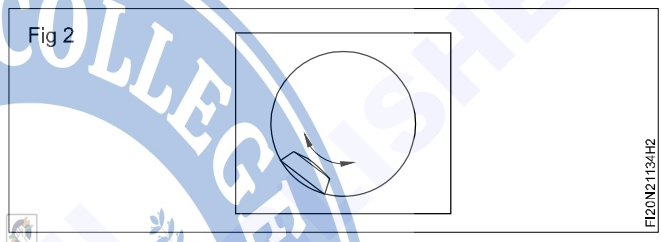
Pressure is exerted with the other hand on the shank for cutting.

Rough scraping will need excessive pressure with longer strokes.

For fine scraping, pressure is reduced and the stroke length also becomes shorter.

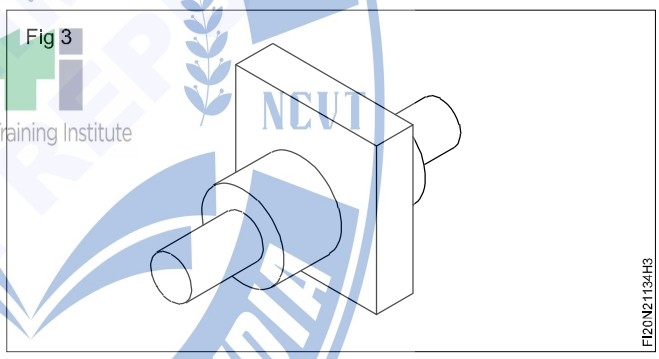
Cutting action takes place both on forward and return strokes Fig 2.

Fig 2



After each pass, change the direction of cutting. This ensures a uniform surface.

Fig 3



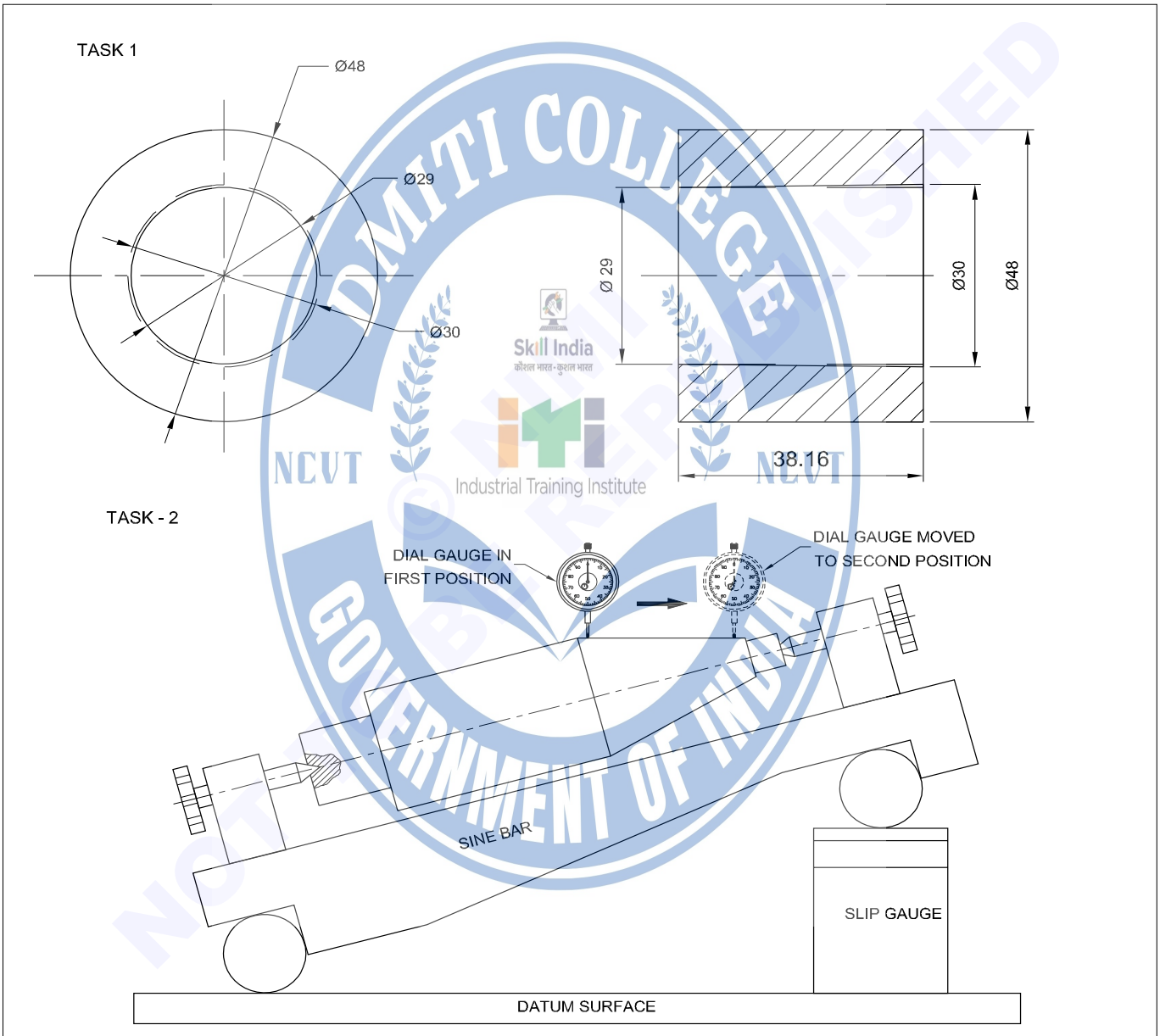
Apply a thin coating of prussion blue on the master bar to locate the high spots.

During the forward movement one cutting edge acts, and on the return stroke, the other cutting edge acts.

Scrapping cylindrical taper bore and check taper angle with sine bar

Objectives: At the end of this exercise you shall be able to

- **turn a round as per drawing**
- **drill centre hole of Ø 28 mm and turn - taper turn 1°30' steep to the major diameter Ø 30**
- **scrap taper bore using half round scraper**
- **hold taper plug gauge in sine bar**
- **build up slip gauge to the required height**
- **set dial test indicator to check parallelism**
- **calculate the taper angle using sine bar and slip gauge.**



1	Ø 50 - 45	-	Fe310	–	TASK 1	2.1.135
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : 1:1	**SCRAPPING CYLINDRICAL TAPER BORE AND CHECK TAPER ANGLE WITH SINE BAR**				TOLERANCE : ±0.02mm	TIME: 8 Hrs
					CODE NO: FI20N21135E1	

Job Sequence

TASK 1: **Scraping in cylindrical taper bore**

- Cut the raw material to its size.
- Turn the round rod to overall dimension in a lathe.
- Centre drill at the centre of the round rod.
- Drill a through hole up to ∅ 28 mm.
- Set the tool in tool post.
- Turn the compound slide to an angle of 1৺30' maintaining major diameter ∅ 30 mm to turn taper.
- Apply prussion blue on taper plug gauge
- Insert and rotate the taper plug gauge to find high spots.
- Scrap and remove high spots using half round scraper.
- Again insert (prussian blue applied) taper plug gauge in the taper hole and rotate. Ensure the uniform spreading of prussian blue around taper bore.
- Fit/match taper plug gauge in the taper hole.
- Apply little oil and preserve it for validation.

TASK 2: **Check taper angle with sine bar**

- Select a suitable sine bar and clean it
- Hold taper plug gauge in a sine bar.
- Select the suitable slip gauge according to taper.
- Build up the slip gauges under the sine bar rollers by wringing method
- Check the parallelism of taper with dial test indicator.
- If DTI's pointer stand still in zero position at both ends of the taper plug gauge, then there is no taper. Instead of that pointer move either direction and shows plus (or) minus reading means errors are there,
- Select the correct slip gauges and keep under the sine bar rollers and correct the parallelism of taper.
- Sine bar length size is hypotenuse.
- Slip gauge height is opposite side
- Marking table serves as adjacent side.

Principle of sine bar is based on trigonometry

$$\text{Sine } \theta = \frac{\text{Opposite side}}{\text{Hypotenuse}}$$

$$\text{Sine } \theta = \frac{\text{Height of the slipgauge}}{\text{Length of the sinebar}}$$

Skill Information

Calculate the angle of taper of plug gauge, slip gauge pack height is 17.36 mm and length of the sine bar is 100 mm

Solution:

Height of slip gauge =17.36 mm

Length of sine bar= 100 mm

$$\text{Angle of taper plug gauge} = \frac{17.36}{100} = 0.1736$$

$\sin \theta = 0.1736$

$\therefore \theta = 10°$

$\therefore$ Angle of taper plug = 10°

Skill Sequence

Use of sine bar and slip gauge

Objectives: This shall help you to

- **state the principal of the sine bar**
- **specify the sizes of sine bars**
- **state the features of sine bars**
- **state the different uses of sine bars.**

A sine bar is a precision measuring instrument for checking and setting of angles Fig 1

The principal of a sine bar is based on the trigonometrical function.

In a right angled triangles the function known as Sine of the angles is the relationship existing between the opposite side to the angle and the hypotenuse Fig 2.

It may be noted that for setting the sine bar to different angles, slip gaugs are used

A surface plate or making table provides the datum surface for the set up.

The sine bar, the slip gauges and the datum surface upon which they are set form a right angles triangle Fig 3. The sine bar forms the hypotenuse (c) and the slip gauge stack forms the side opposite.

Fig 1

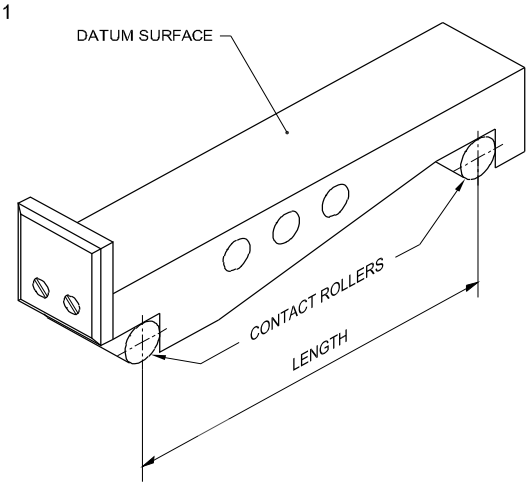


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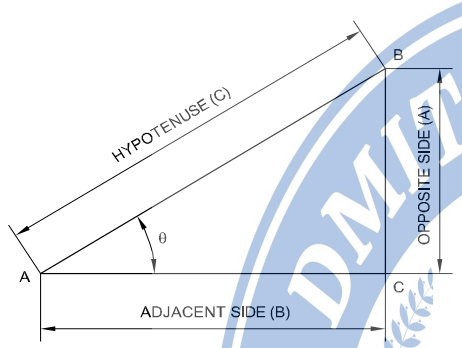
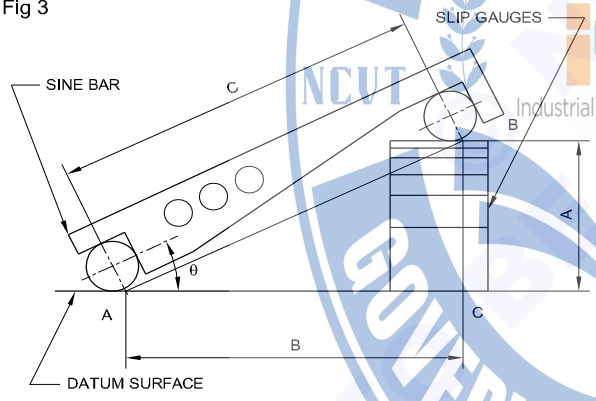
Fig 2



FI20N21135H2

Fig 3



FI20N21135H3

$$\text{Sine of the angle } \theta = \frac{\text{Opposite side}}{\text{Hypotenuse}}$$

$$\text{Sine } \theta = \frac{a}{c}$$

Features is a rectangular bar made of stabilized chromium steel.

The surfaces are accurately finished by grinding and lapping.

Two precision rollers of the same diameter are mounted on either end of the bar. The centre line of the rollers is parallel to the top face of the sine bar.

There are holes drilled across the bar. This helps in reducing the weight and also it facilitates clamping of sine bar on angel plate.

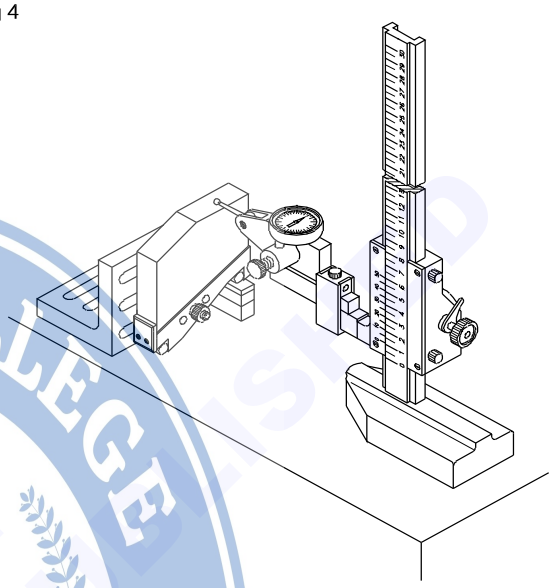
The length of the sine bar is the distance between the centres of the rollers. The commonly available sizes are 100 mm, 200 mm, 250 mm and 500 mm. The size of a sine bar is specified by its length.

Uses

Sine bars are used when a high degree of accuracy to less than one minute is needed for

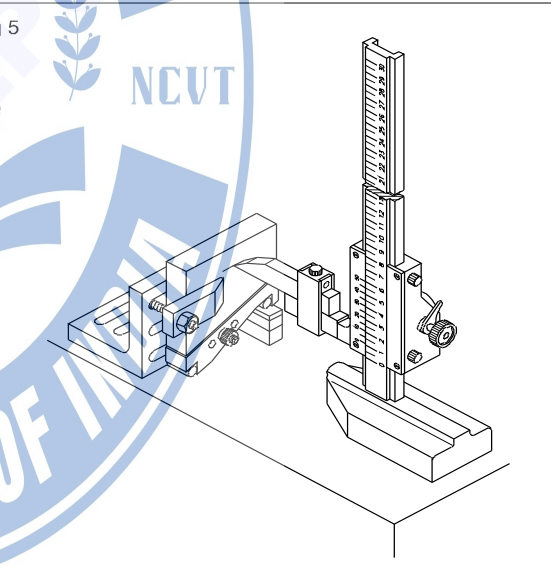
- measuring angles Fig 4.
- marking out Fig 5.
- setting up for machining Fig 6.

Fig 4



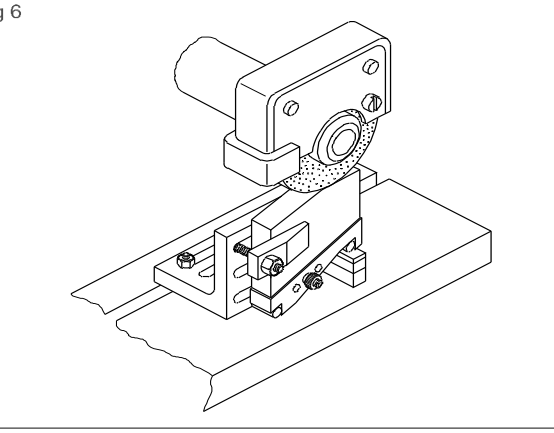
FI20N21135H4

Fig 5



FI20N21135H5

Fig 6



FI20N21135H6

Determining taper using sine bar and slip gauges

Objectives: This shall help you to
- **determine correctness of a known angle**
- **calculate the height of slip gauges to a known angle.**

Sine bars provide a simple means of checking angles to a high degree of accuracy of not less than one minute up to 45°

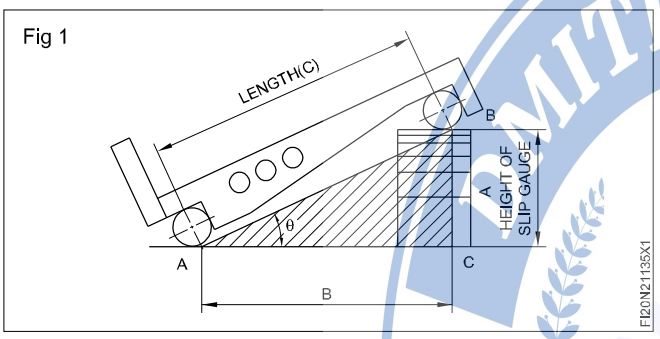
The use of a sine bar is based on trigonometric function. The sine bar forms the hypotenuse of the triangle and the slip gauges the opposite side Fig 1.

Checking the correctness of a known angle

For this purpose first choose the correct slip gauge combination for the angle to be checked.

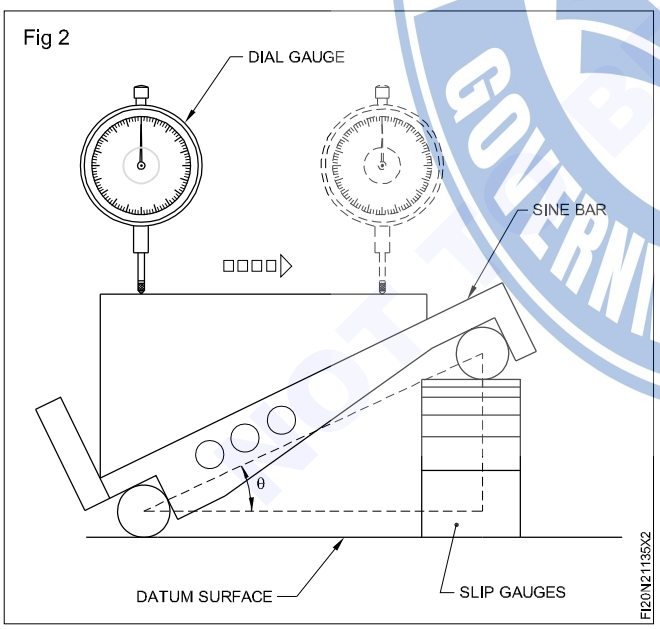
The component to be checked should be mounted on the sine bar after placing the seleted slip gauges under the roller Fig 1.

Fig 1



A dial test indicator is mounted on a suitable stand or vernier height gauge Fig 2. The dial test indicator is then set in first position as in the figure and the dial is set of zero.

Fig 2

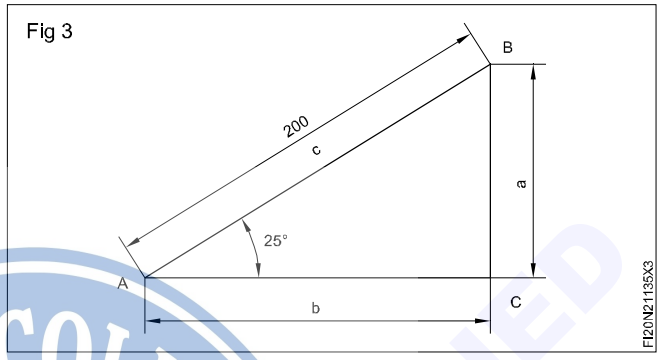


Move the dial to the other end of the component (second position). If there is any differnece then the angle is incorrect. The height of the slip gauge pack can be adjusted until the dial test indicator reads zero on both ends. The actual angle can then be caluculated and the deviation, if any, will be the error.

Method calculating the slip gauge height

Example Fig 3

Fig 3



Exercise 1

To determine the height of slip gauges for an angle of 25 °using a sine bar of 200 mm long.

$$Sine\,\theta = \frac{a}{c}$$

$$\theta = 25°$$

$$a = C Sine\,\theta$$

$$= 200 \times 0.4226$$

$$a = 84.52 mm$$

The height of the slip gauge required is 84.52 mm.

> **The value of sine θ can be obtained from mathematical tables. (Natural trigonometrical functions).**

Tables are also available with readly worked out sine bar constants for standard sine bar lengths.

Calculating the angle for tapered components

Exercise 2

The height of the slip gauge used is 84.52 mm. The length of the sine bar used is 200 mm.

$$\text{Sine } \theta = \frac{a}{c}$$

$$= \frac{84.52}{200}$$

$$\text{Sine } \theta = 0.4226$$

The angle whose sine value is 0.4226 is 25°. Hence the angle of tapered component is 25°.

Classroom Assignment

1 What will be angle of the workpiece if the slip gauge

pack height is 17.36 mm and the size of the sine bar used is 100 mm? Fig 5.

Answer _____

2 Calculated the height of the slip gauge pack to raise a 100 mm sine bar to an angle of 3° 35'.

Answer _____

Fig 4

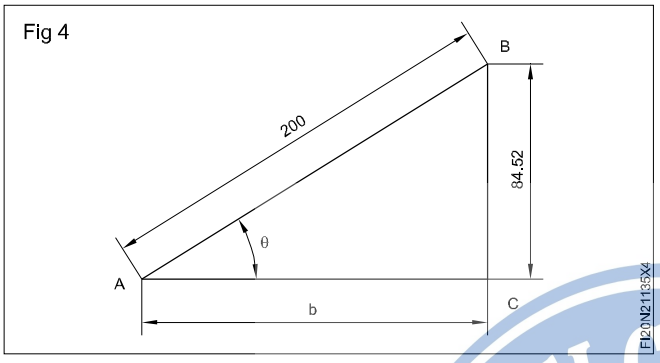
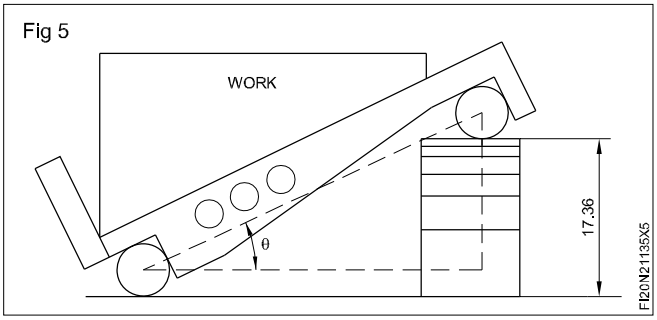


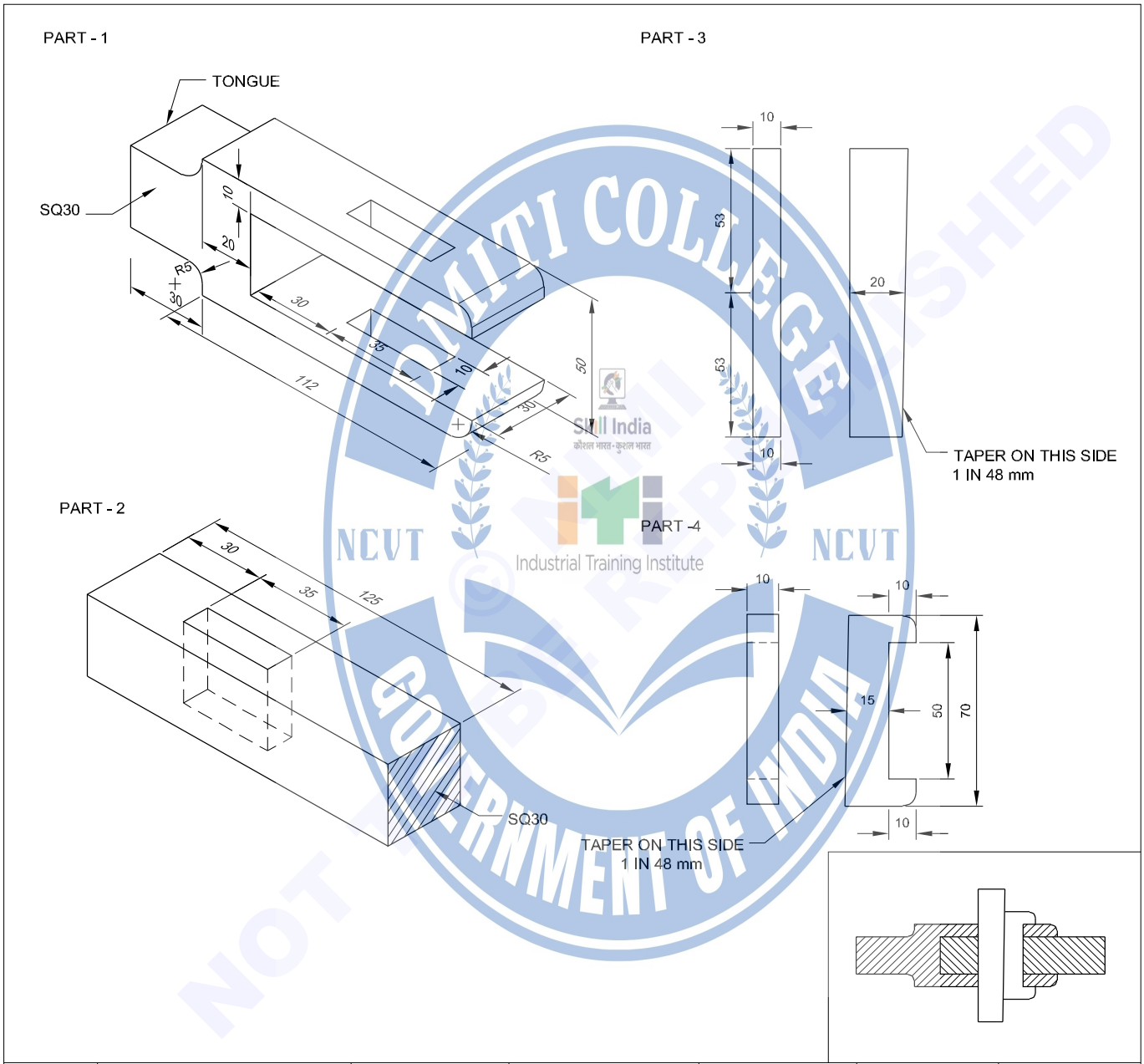
Fig 5



Make a cotter jib assembly

Objectives: At the end of this exercise you shall be able to

- **file flat surfaces to square and parallel**
- **mark dimensions as per drawing with vernier height gauge**
- **measure the dimensions with vernier caliper**
- **file and assemble maintaining accuracy to ± 0.02**



1	55X32X145	--	Fe310	--	1	2.1.136
1	32 SQ RODX130	--	Fe310	--	2	2.1.136
1	30X12X80	--	Fe310	--	3	2.1.136
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE	**MAKE A COTTER GIB ASSEMBLY**				DEVIATIONS	TIME: 20 Hrs
					CODE NO. FI20N21136E1	

Job Sequence

Check the raw materials for its sizes as per drawing.

Part 1

- File part 1 raw material to size 50.x 30 x 142 mm maintaining the dimensional tolerance as per drawing, flatness and squareness
- Mark of part 1 with vernier height gauge as per drawing
- Punch witness marks.
- Chain drill hole in part 1 for making 30 x 92 mm open slot and 10 x 35 mm through slot.
- Hack saw and cut off along the chain drilled holes using web chisel and ball pein hammer.
- File the open slot and through slot to size.
- Hacksaw and remove excess metal on tongue side and file to size.
- File radius R5 whereever mentioned.

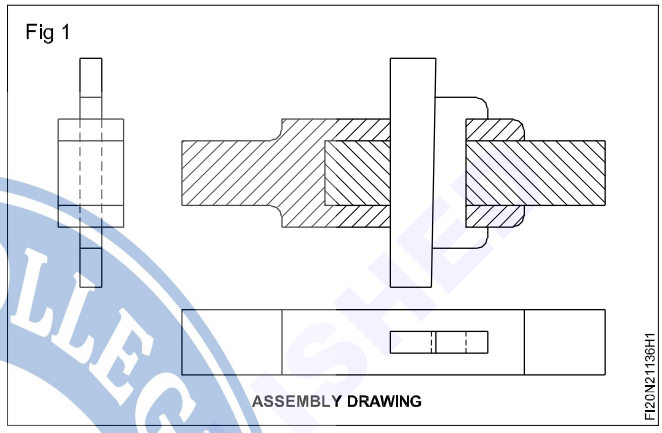
Part 2

- FIle part 2 raw material to size SQ 30 x 125mm, maintaining the dimensional tolerance as per drawing Flatness and squareness.
- Mark 10 x 35mm through slot and punch witness marks.
- Chain drill hole in part 2 for making through slot.
- Hacksaw and cut off along the chain drilled holes using web chisel and ball pein hammer.
- File the through slot to size.

Part 3 & Part 4

- File part 3 and part 4 to over all size and maintain the dimensional tolerance as per drawing, flatness and squareness.
- Mark part 3 and part 4 according to drawing and file to the size.

Fig 1



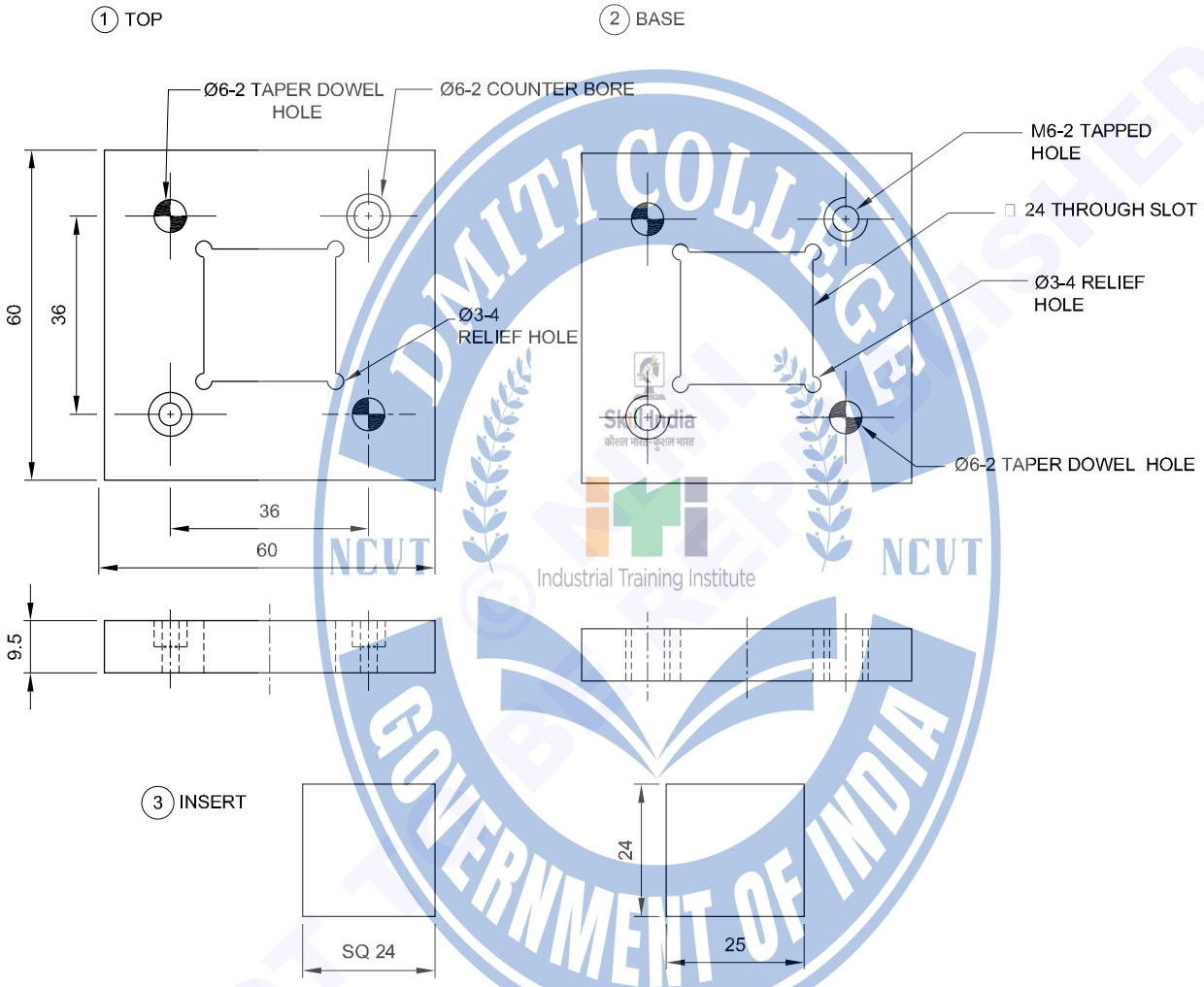
Insert part 2 in part 1 as shown in assemble drawing.

Insert part 3 and part 4 together by aligning part 1 as shown in assembly drawing. (Fig 1)

Hand reams and fit taper pin

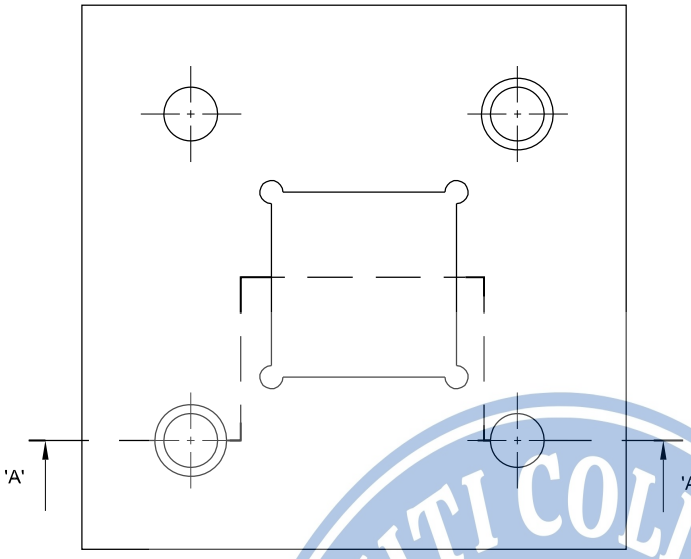
Objectives: At the end of this exercise you shall be able to

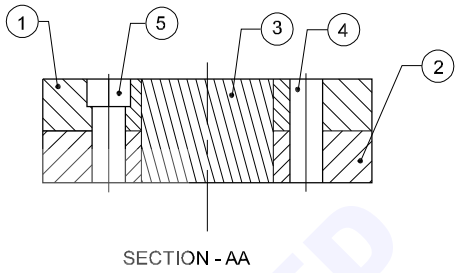
- **file to shape and size as per drawing**
- **mark square and taper dowel pin location**
- **step drill to ream taper pin hole and drill relief hole, chain drilling**
- **fix taper dowel pin and cheese head screw as per drawing fit part – 2 in assemble setting as per drawing.**



2	M6-18	CHEESE HD SCREW	Fe310	–	5	2.1.137
2	Ø6-18	TAPPER DOWEL PIN	Fe310	–	4	2.1.137
1	SQ 25-27	INSERT	Fe310	–	3	2.1.137
1	65 ISF 10-65	BASE PLATE	Fe310	–	2	2.1.137
1	65 ISF 10-65	TOP PLATE	Fe310	–	1	2.1.137
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE :1:1	HAND REAMS AND FIT TAPER PIN	TOLERANCE : ±0.02mm	TIME: 12 Hrs
		CODE NO: FI20N21137E1	



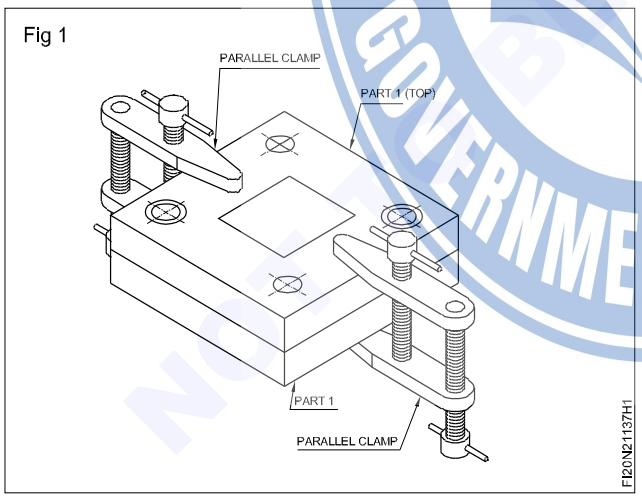


SECTION - AA

Job Sequence

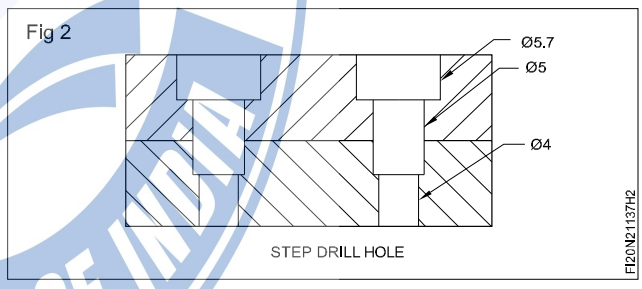
- Check the given raw materials for its size.
- File raw metal to size 60 x 60 x 9.5 mm in two pieces and check the dimensions using vernier caliper.
- Check the flatness and squareness using try square.
- Apply marking medium and mark off square and entre line for dowel pin holes and cheese head screw holes and punch witness mark and centre punch marks on the job.
- Place part 2 on part 1 assemble and clamp the setting with parallel clamp and check the squareness of the assembled parts Fig 1.

Fig 1



- Fix centre drill in drilling machine and centre drill to locate all the spot of hole position as per drawing.
- Fix ∅ 4 mm drill in drilling machine and drill a through hole in the place of taper dowel pin assembly.
- Similarly fix ∅ 5.7mm drill rod step hole to the depth 2/3 portion of the drilled hole and fix ∅ 5.7mm drill and step drill hole to the depth of 1/3rd portion of the drilled hole in the place of taper dovel pin assembly Fig 2.

Fig 2



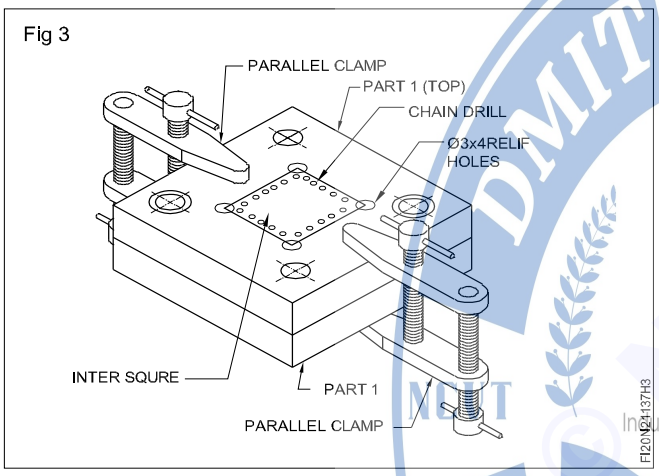
- Fix taper pins reamer in tap wrench and ream a step drill hole to the taper hole to suit taper dowel pin in the assembly without disturbing the assembly setting (use plenty of oil while reaming)
- Fix taper dowel pin in the reamed taper hole through push fit
- Similarly repeat the above working steps and complete the above procedures to fix another taper

						2.1.137
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : NTS	**HAND REAM AND FIT TAPER PIN ASSEMBLY**				TOLERANCE :	TIME:
					CODE NO: FI20N21137E2	

dowel pin in the assembly through push fit as per drawing.

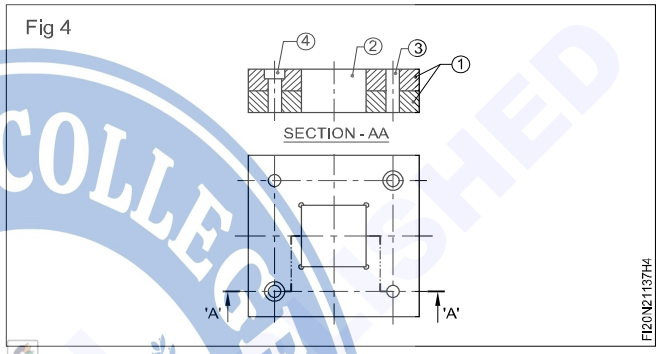
- Fix ∅ 6.0 mm drill in drilling machine and drill a through hole in the place of cheese head screw assembly.
- Fix ∅ 12 x 6.0 mm counter bore tool and counter bore to the depth of cheese head screw head thickness in part 2 top plate and cut M 6 internal thread in the place of cheesehead screw assembly in base plate.
- Fix M 6 x 18 mm cheese head screw in the internal threaded hole
- Similarly repeat the above working steps and complete the above procedure to fix outer cheese head screw in the assembly.
- Fix ∅ 3 mm drill in drilling machine and drill relief holes as per drawing.
- Fix ∅ 6 mm drill in drilling machine and drill chain drilling to remove unwanted metal in internal square Part – 1 and Part -2 (Base & top plate) Fig 3.

Fig 3



- Dis assemble the setting from drilling machine table and chip and remove the un wanted metal using .. chisel and ball pein hammer in part of (base) and (top)
- Re-assemble the part – 1 (base) and (top) along with taper dowel pins and cheese head screw and file internal square to size and 90 ° angle and measure the dimensions with vernier caliper.
- **PART 3**
- File part 3 raw metal to size in square bar 24 x 24 x 25 mm and check the dimensions with vernier caliper
- Check the flatness and squareness in try square.
- Fit Part 3 in push fit in the assemble part - 1 and part -2 (base) and top Fig 4

Fig 4

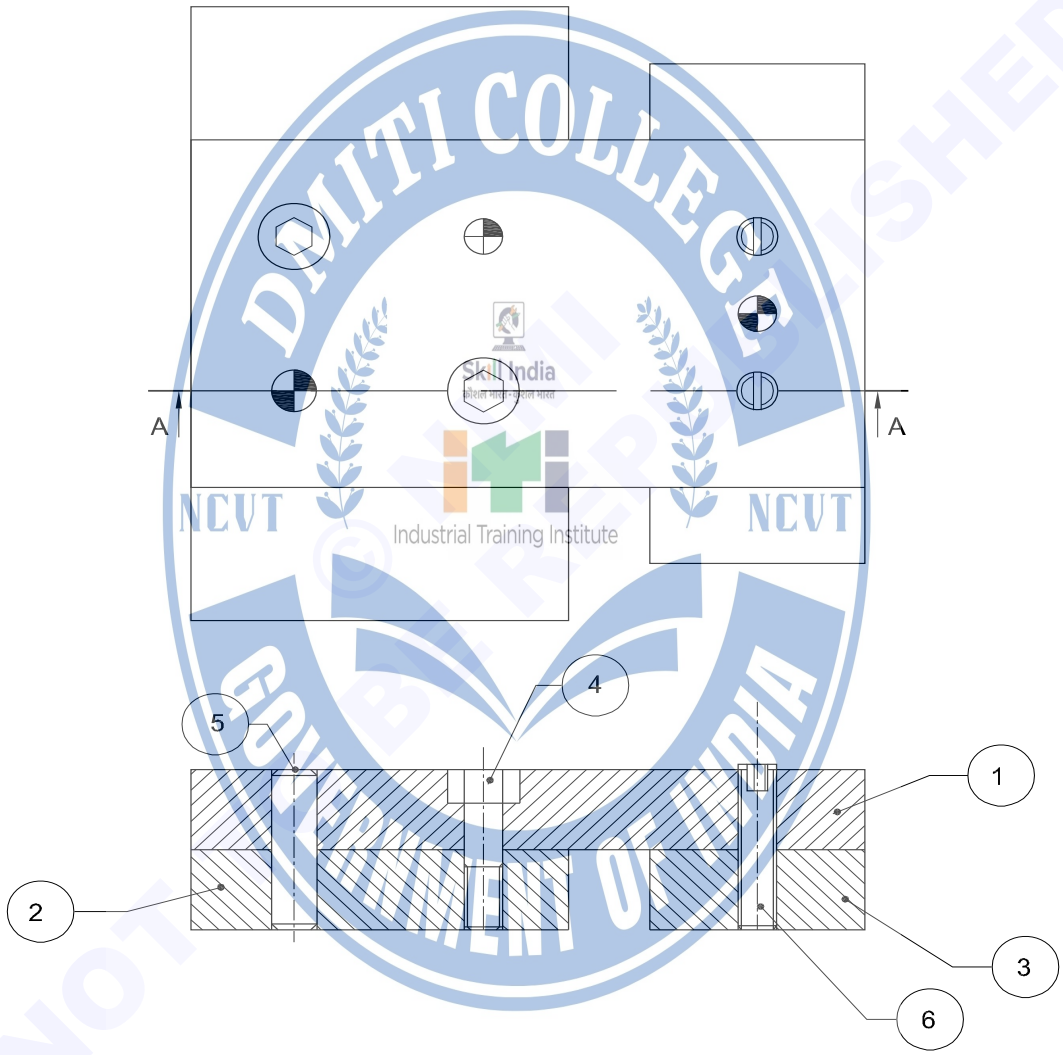


- Dis assemble all the parts and finish all the surfaces and remove burrs from all the corners of the parts of assembly
- Re-assemble all the parts and fit part 3 in push fit and apply little oil and preserve it for evaluation.

Drilling and reaming holes in correct location, fitting dowel pins, stud, and bolts

Objectives: At the end of this exercise you shall be able to

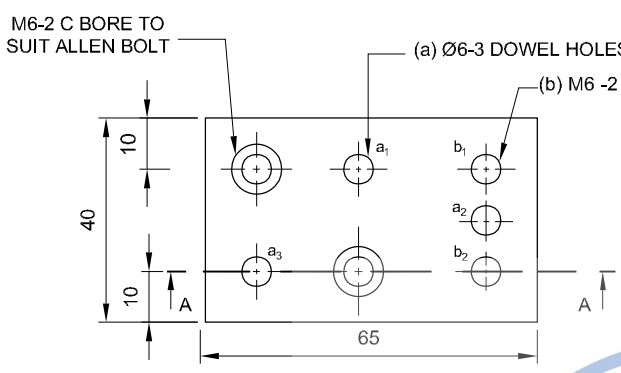
- **file to size as per drawing**
- **mark and punch hole locations**
- **drill, ream, counter bore as per drawing**
- **cut M 6 internal thread to suit bolt and stud**
- **assemble as per drawing.**



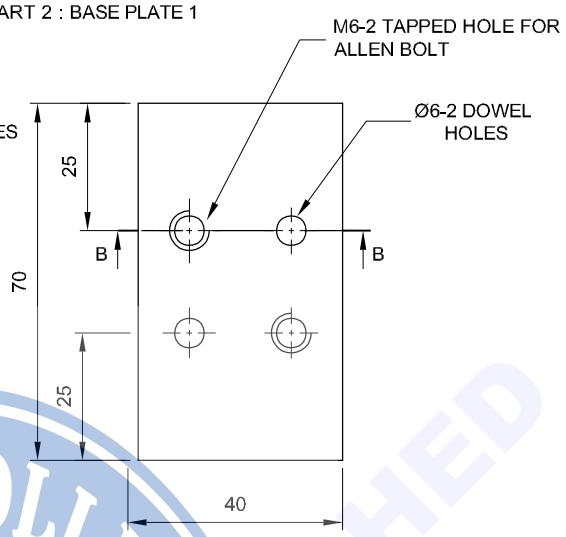
2	M6-18	STUD	Fe310	–	6	2.1.138
3	STANDARD Ø6-18	DOWEL PIN	Fe310	–	5	2.1.138
2	STANDARD M6-16	HEXAGON BOLT	Fe310	–	4	2.1.138
1	65 ISF 10-25	BASE 2	Fe310	–	3	2.1.138
1	50 ISF 10-75	BASE 1	Fe310	–	2	2.1.138
1	50 ISF 10-70	TOP PLATE	Fe310	–	1	2.1.138
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

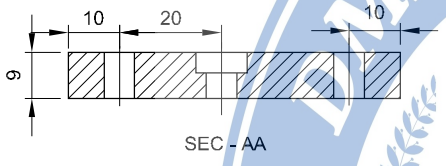
SCALE : NTS	**DRILLING AND REAMING HOLES IN CORRECT LOCATION, FITTING DOWEL PINS, STUD, AND BOLTS**	TOLERANCE : ±0.02mm	TIME: 8 Hrs
		CODE NO: FI20N21138E1	

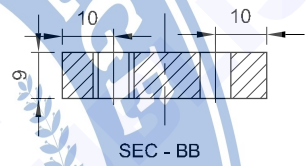
PART 1 : TOP PLATE



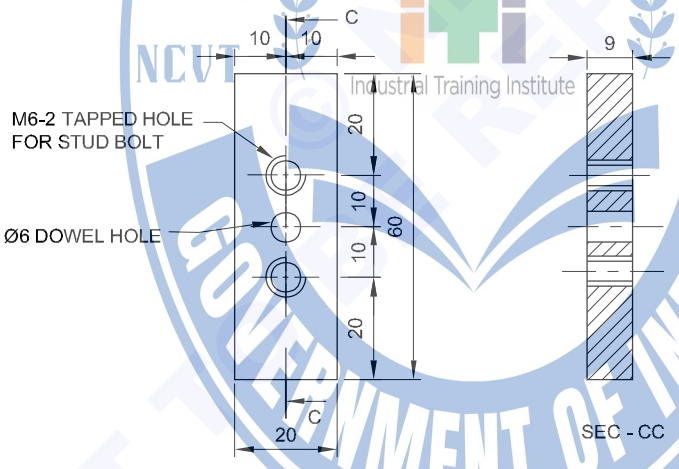
PART 2 : BASE PLATE 1



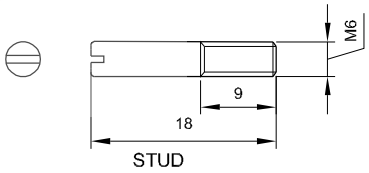




PART 3 BASE PLATE 2



PART 6

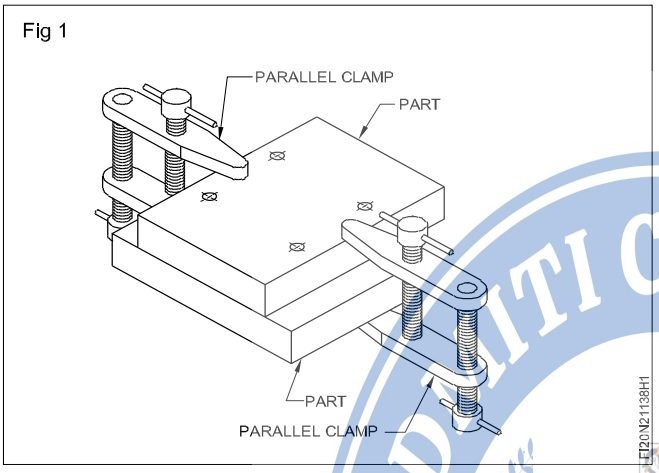


						2.1.138
NO.OFF	STOCK SIZE		SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE :	**DRILLING AND REAMING HOLES IN CORRECT LOCATION,FITTING DOWEL PINS,STUD AND BOLTS**					TOLERANCE :	TIME:
						CODE NO: FI20N21138E2	

Job Sequence

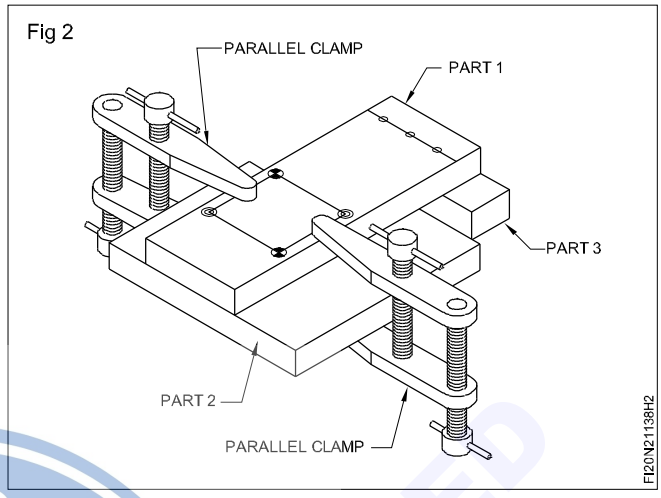
- Check the raw material for its size.
- File Part 1,2,3 to size and check with vernier caliper
- Apply marking medium and mark as per drawing
- Punch drill hole marks as per drawing
- Set Part 1 and 2 as per drawing and clamp it with parallel clamp as shown in Fig:1

Fig 1



- Fix ∅ 5.8 mm drill in drilling machine and drill through holes and ream the holes of ∅ 6 mm reamer in part 1 and 2.
- Clean the reamed hole with soft cloth and fit ∅ 6 mm dowel pin.
- Similarly drill, ream and fit ∅ 6 another dowel pin with the same setting in part 1 and 2 as shown in Fig 1.
- Then fix ∅ 5 mm drill in drilling machine and drill through hole for M 6 hexagon bolt assembly.
- Similarly drill ∅ 5 mm drill hole in part 1 and 2 for another M 6 hexagon bolt assembly.
- Counter bore to the depth of fixing M 6 allen bolt head side in part 1 as shown in drawing.
- Separate Part 1 and 2.
- Hold counter sink tool in drilling and machine and counter sink 1 x 45° in the place of cutting internal thread on both sides of part 2 (Thread has been cut in part 2 only).
- Cut M6 internal thread in the place of hexagon bolts assembly in part 2.

Fig 2



- Clean the threads without burrs.
- Reassemble part 1 and 2 and set part 3 as shown in Fig:2 and clamp it with parallel clamps.
- Then fix ∅ 5.8 mm drill in drilling machine and drill through hole ream ∅ 6 mm for dowel pin assemble with part 1 and 3.
- Fit ∅ 5 mm drill and drill two through holes in the place of studs assembly in part 1 and 3
- Separate part 1 and 3
- Fix ∅ 6 mm drill and drill through holes in part 1
- Countersink 1 x 45° in part 3 and cut M6 internal thread (thread has been cut in part 3 only).
- Clean the thread and re-assemble part 1 with part 3.
- Prepare stud as per (part - 6) drawing.
- Fix two studs in part 3 and assemble with part 1 as shown in figure.
- Fix M6 bolt along with plain washer and tighten it using suitable spanner.
- Disassemble all the parts (1,2 and 3) and finish with file and deburr on all surfaces of the job.
- Re-assemble all the parts (1,2 and 3) with dowel pins, hexagon bolts, stud and nuts.
- Apply thin coat of oil and preserve it for evaluation.