FITTER
NSQF LEVEL - 5

2nd Year (Volume I of II)

TRADE PRACTICAL

SECTOR: Capital Goods & Manufacturing

DIRECTORATE GENERAL OF TRAINING
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
GOVERNMENT OF INDIA

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

Post Box No. 3142, CTI Campus, Guindy, Chennai - 600 032.
Sector: Capital Goods and Manufacturing
Duration: 2 Years
Trade: Fitter - 2nd year (Volume I of II) Trade Practical NSQF (Level - 5)

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FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, by 2020 to help them secure jobs as part of the National Skills Development Policy. Industrial Training Institutes (ITIs) play a vital role in this process especially in terms of providing skilled manpower. Keeping this in mind, and for providing the current industry relevant skill training to Trainees, ITI syllabus has been recently updated with the help of Mentor Councils comprising various stakeholder's viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai has now come up with instructional material to suit the revised curriculum for Fitter 2nd Year Trade Practical NSQF Level - 5 in Capital Goods and Manufacturing Sector under Annual Pattern. The NSQF Level - 5 Trade Practical will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF Level - 5 trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 5 the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

The Executive Director & Staff of NIMI and members of Media Development Committee deserve appreciation for their contribution in bringing out this publication.

Jai Hind

Director General,
Directorate General of Training,
Ministry of Skill Development & Entrepreneurship,
Government of India.

New Delhi - 110 001
The National Instructional Media Institute (NIMI) was established in 1986 at Chennai by then Directorate General of Employment and Training (D.G.E & T), Ministry of Labour and Employment, (now under Directorate General of Training, Ministry of Skill Development and Entrepreneurship) Government of India, with technical assistance from the Govt. of the Federal Republic of Germany. The prime objective of this institute is to develop and provide instructional materials for various trades as per the prescribed syllabi under the Craftsman and Apprenticeship Training Schemes.

The instructional materials are created keeping in mind, the main objective of Vocational Training under NCVT/NAC in India, which is to help an individual to master skills to do a job. The instructional materials are generated in the form of Instructional Media Packages (IMPs). An IMP consists of Theory book, Practical book, Test and Assignment book, Instructor Guide, Audio Visual Aid (Wall charts and Transparencies) and other support materials.

The trade practical book consists of series of exercises to be completed by the trainees in the workshop. These exercises are designed to ensure that all the skills in the prescribed syllabus are covered. The trade theory book provides related theoretical knowledge required to enable the trainee to do a job. The test and assignments will enable the instructor to give assignments for the evaluation of the performance of a trainee. The wall charts and transparencies are unique, as they not only help the instructor to effectively present a topic but also help him to assess the trainee's understanding. The instructor guide enables the instructor to plan his schedule of instruction, plan the raw material requirements, day to day lessons and demonstrations.

In order to perform the skills in a productive manner instructional videos are embedded in QR code of the exercise in this instructional material so as to integrate the skill learning with the procedural practical steps given in the exercise. The instructional videos will improve the quality of standard on practical training and will motivate the trainees to focus and perform the skill seamlessly.

IMPs also deals with the complex skills required to be developed for effective team work. Necessary care has also been taken to include important skill areas of allied trades as prescribed in the syllabus.

The availability of a complete Instructional Media Package in an institute helps both the trainer and management to impart effective training.

The IMPS are the outcome of collective efforts of the staff members of NIMI and the members of the Media Development Committees specially drawn from Public and Private sector industries, various training institutes under the Directorate General of Training (DGT), Government and Private ITIs.

NIMI would like to take this opportunity to convey sincere thanks to the Directors of Employment & Training of various State Governments, Training Departments of Industries both in the Public and Private sectors, Officers of DGT and DGT field institutes, proof readers, individual media developers and coordinators, but for whose active support NIMI would not have been able to bring out this materials.

R. P. DHINGRA
EXECUTIVE DIRECTOR

Chennai - 600 032
ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisations to bring out this Instructional Material (Trade Practical) for the trade of Fitter under Capital Goods and Manufacturing Sector for ITIs.

MEDIA DEVELOPMENT COMMITTEE MEMBERS

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Institute/Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shri. A. Vijayaraghavan</td>
<td>Assistant Director of Training (Retd.)</td>
<td>ATI, Chennai -32</td>
</tr>
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<td>Training officer (Retd.)</td>
<td>CTI, Chennai-32.</td>
</tr>
<tr>
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<td>CTI, Chennai - 32</td>
</tr>
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</tr>
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<table>
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<tr>
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<tbody>
<tr>
<td>Shri. K. Srinivasa Rao</td>
<td>Joint Director</td>
<td>NIMI, Chennai - 32</td>
</tr>
<tr>
<td>Shri. G. Michael Johny</td>
<td>Assistant Manager</td>
<td>NIMI, Chennai - 32</td>
</tr>
<tr>
<td>Shri. V. Gopalakrishnan</td>
<td>Assistant Manager</td>
<td>NIMI, Chennai - 32</td>
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</table>

NIMI records its appreciation for the Data Entry, CAD, DTP operators for their excellent and devoted services in the process of development of this Instructional Material.

NIMI also acknowledges with thanks the invaluable efforts rendered by all other NIMI staff who have contributed towards the development of this Instructional Material.

NIMI is also grateful to everyone who has directly or indirectly helped in developing this Instructional Material.
INTRODUCTION

TRADE PRACTICAL

The trade practical manual is intended to be used in practical workshop. It consists of a series of practical exercises to be completed by the trainees during the 2nd Year Course of the Fitter Trade supplemented and supported by instructions/informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in compliance with NSQF LEVEL - 5 syllabus are covered.

The manual is divided into three modules. The distribution of time for the practical in the three modules are given below.

<table>
<thead>
<tr>
<th>Module 1</th>
<th>Assembly - 1</th>
<th>325 Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module 2</td>
<td>Gauges</td>
<td>125 Hrs</td>
</tr>
<tr>
<td>Module 3</td>
<td>Pipes and pipe fittings</td>
<td>75 Hrs</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>525 Hrs</strong></td>
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</table>

The skill training in the shop floor is planned through a series of practical exercises centred around some practical project. However, there are few instances where the individual exercise does not form a part of project.

While developing the practical manual a sincere effort was made to prepare each exercise which will be easy to understand and carry out even by below average trainee. However the development team accept that there is a scope for further improvement. NIMI looks forward to the suggestions from the experienced training faculty for improving the manual.

TRADE THEORY

The manual of trade theory consists of theoretical information for the Third Semester Course of the Fitter Trade. The contents are sequenced according to the practical exercise contained in NSQF LEVEL - 5 syllabus on Trade practical. Attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This correlation is maintained to help the trainees to develop the perceptual capabilities for performing the skills.

The Trade Theory has to be taught and learnt along with the corresponding exercise contained in the manual on trade practical. The indications about the corresponding practical exercises are given in every sheet of this manual.

It will be preferable to teach/learn the trade theory connected to each exercise at least one class before performing the related skills in the shop floor. The trade theory is to be treated as an integrated part of each exercise.

The material is not for the purpose of self learning and should be considered as supplementary to class room instruction.
<table>
<thead>
<tr>
<th>Exercise No.</th>
<th>Title of the Exercise</th>
<th>Learning Outcome</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
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<td>3.1.117</td>
<td>Make - H - Fitting</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>3.1.118</td>
<td>Power tools: Practice operation of power tool for fastening</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>3.1.119</td>
<td>Tightening of bolt/screw with specified torque</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>3.1.120</td>
<td>Selection of right tool as for tightening or loosening of screw/bolt as per accessibility</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>3.1.121</td>
<td>Assembly sliding for using keys, dowel pin and screw, ± 0.02 mm accuracy on plain surface and testing of sliding fitting job</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>3.1.122</td>
<td>File &amp; fit angular mating surface within an accuracy of ± 0.02 mm &amp; 10 minutes angular fitting</td>
<td></td>
<td>12</td>
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<tr>
<td>3.1.123</td>
<td>Drill through and blind holes at an angle using swivel table of drilling machine</td>
<td></td>
<td>14</td>
</tr>
<tr>
<td>3.1.124</td>
<td>Precision drilling, reaming and tapping and test - job</td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>3.1.125</td>
<td>Make dovetailed fitting and radius fitting</td>
<td></td>
<td>19</td>
</tr>
<tr>
<td>3.1.126</td>
<td>File and fit, combined fit with straight, angular surface with ± 0.02 mm accuracy and check adherence to specification and quality standards using equipment like vernier calipers, micrometers etc.</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>3.1.127</td>
<td>Drilling and reaming small dia. holes to accuracy &amp; correct location for fitting</td>
<td></td>
<td>24</td>
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<tr>
<td>3.1.128</td>
<td>Perform drilling using 'V' Block and a clamp</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>3.1.129</td>
<td>Make male and female fitting parts, drill &amp; ream holes not less than 12.7mm</td>
<td></td>
<td>28</td>
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<tr>
<td>3.1.130</td>
<td>Make sliding diamond fitting</td>
<td></td>
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<tr>
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<td>Lap flat surfaces using lapping plate</td>
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<td>Prepare stepped keyed fitting and test job</td>
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<td>3.1.133</td>
<td>Lapping holes and cylindrical surfaces</td>
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<td>3.1.134</td>
<td>Dovetail and dowel pin assembly</td>
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<tr>
<td>3.1.135</td>
<td>Scrape cylindrical bore</td>
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<td>3.1.136</td>
<td>Scrapping cylindrical bore and to make a fit</td>
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<td>3.1.137</td>
<td>Scrapping cylindrical taper bore and check taper angle with sine bar</td>
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<td>3.1.138</td>
<td>Make a cotter gib assembly</td>
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<td>3.1.139</td>
<td>Hand reams and fit taper pin</td>
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<tr>
<td>3.1.140</td>
<td>Drilling and reaming holes in correct location, fitting dowel pins, stud &amp; bolts</td>
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</table>

**Module 1: Assembly - 1**

**Module 2: Gauges**

<table>
<thead>
<tr>
<th>Exercise No.</th>
<th>Title of the Exercise</th>
<th>Learning Outcome</th>
<th>Page No.</th>
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<td>Making a snap gauge for checking a dia. of 10 ± 0.02mm</td>
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<td>3.2.142</td>
<td>Scrape external angular mating surface and check angle with sine bar</td>
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<td>64</td>
</tr>
<tr>
<td>3.2.143</td>
<td>Scrape on internal surface and check</td>
<td></td>
<td>69</td>
</tr>
<tr>
<td>3.2.144</td>
<td>Practice in dovetail fitting assembly and dowel pins and cap screws assembly</td>
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<td>2</td>
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<tr>
<td>3.2.145</td>
<td>Industrial visit</td>
<td></td>
<td>72</td>
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3.2.148 Preparation of drill gauges 2 85
3.2.149 File and fit straight and angular surfaces internally 89
3.2.150 Identify different ferrous metals by spark test 91

Module 3: Pipes and pipe fittings

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3.3.152 Cutting and threading of pipe length 101
3.3.153 Fitting of pipes as per sketch observing conditions used for pipe work 103
3.3.154 Bending of pipes - cold and hot 107
3.3.155 Dismantling & assembling - globe valves, sluice valves, stop cocks, seat valves and non-return valve 3 116
3.3.156 Fit & assemble pipes, valves and test for leakage & functionality of valves 126
3.3.157 Visual inspection for visual defects e.g. dents, surface finish 133
3.3.158 Measuring, checking and recording in control chart 136

LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

<table>
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<th>Exercise No.</th>
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<th>Learning Outcome</th>
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<tbody>
<tr>
<td>3.2.147</td>
<td>Perform lapping of gauges (hand lapping only)</td>
<td></td>
<td>83</td>
</tr>
<tr>
<td>3.2.148</td>
<td>Preparation of drill gauges</td>
<td></td>
<td>2 85</td>
</tr>
<tr>
<td>3.2.149</td>
<td>File and fit straight and angular surfaces internally</td>
<td></td>
<td>89</td>
</tr>
<tr>
<td>3.2.150</td>
<td>Identify different ferrous metals by spark test</td>
<td></td>
<td>91</td>
</tr>
<tr>
<td>3.3.151</td>
<td>Flaring of pipes and pipe joints</td>
<td></td>
<td>94</td>
</tr>
<tr>
<td>3.3.152</td>
<td>Cutting and threading of pipe length</td>
<td></td>
<td>101</td>
</tr>
<tr>
<td>3.3.153</td>
<td>Fitting of pipes as per sketch observing conditions used for pipe work</td>
<td></td>
<td>103</td>
</tr>
<tr>
<td>3.3.154</td>
<td>Bending of pipes - cold and hot</td>
<td></td>
<td>107</td>
</tr>
<tr>
<td>3.3.155</td>
<td>Dismantling &amp; assembling - globe valves, sluice valves, stop cocks, seat valves and non-return valve</td>
<td></td>
<td>3 116</td>
</tr>
<tr>
<td>3.3.156</td>
<td>Fit &amp; assemble pipes, valves and test for leakage &amp; functionality of valves</td>
<td></td>
<td>126</td>
</tr>
<tr>
<td>3.3.157</td>
<td>Visual inspection for visual defects e.g. dents, surface finish</td>
<td></td>
<td>133</td>
</tr>
<tr>
<td>3.3.158</td>
<td>Measuring, checking and recording in control chart</td>
<td></td>
<td>136</td>
</tr>
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LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

<table>
<thead>
<tr>
<th>S.No</th>
<th>Learning Outcome</th>
<th>Exercise No</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Make &amp; assemble components of different mating surfaces as per required tolerance by different surface finishing operations using different fastening components, tools and check functionality. [Different mating surfaces - Dovetail fitting, Radius fitting, Combined fitting, Different surface finishing operations- Scarping, Lapping and Honing. Different fastening components - Dowel pins, Screws, Bolts, Keys &amp; Cotters. Different fastening tools - Hand operated &amp; Power tools, Required tolerance - ± 0.02 mm, angular tolerance ± 10 min].</td>
<td>3.1.117 to 3.1.140</td>
</tr>
<tr>
<td>2</td>
<td>Make different gauges by using standard tools &amp; equipment and check it for specified accuracy. [Different gauges - Snap gauge, Gap gauge; specified accuracy ± 0.02 mm].</td>
<td>3.2.141 to 3.2.150</td>
</tr>
<tr>
<td>3</td>
<td>Apply a range of skills to execute pipe joints, dismantle and assemble valves &amp; fittings with pipes and test for leakages. [Range of skills - Cutting, Threading, Flaring, Bending and Joining].</td>
<td>3.3.151 to 3.3.158</td>
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<tr>
<td>Week No.</td>
<td>Ref. Learning Outcome</td>
<td>Professional Skills (Trade Practical) with Indicative hours</td>
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<tr>
<td>53</td>
<td>Make &amp; assemble components of different mating surfaces as per required tolerance by different surface finishing operations using different fastening components, tools and check functionality. [Different Mating Surfaces – Dovetail fitting, Radius fitting, Combined fitting; Different surface finishing operations – Scraping, Lapping and Honing; Different fastening components – Dowel pins, screws, bolts, keys and cotters; Different fastening tools-hand operated &amp; power tools, Required tolerance - ±0.02mm, angular tolerance ± 10 min.]</td>
<td>117. Make H. fitting (17 hrs.)&lt;br&gt;118. Power tools: Practice operation of power tool for fastening (5 hrs.)&lt;br&gt;119. Tightening of bolt/ screw with specified torque (2 hrs.)&lt;br&gt;120. Selection of right tool as for Tightening or loosening of screw/bolt as per accessibility (1 hrs.)</td>
</tr>
<tr>
<td>54</td>
<td>-do-</td>
<td>121. Assembly sliding for using keys, dowel pin and screw, ± 0.02 mm accuracy on plain surface and testing of sliding fitting job (25 hrs.)</td>
</tr>
<tr>
<td>55</td>
<td>-do-</td>
<td>122. File &amp; fit angular mating surface within an accuracy of ± 0.02 mm &amp; 10 minutes angular fitting (25 hrs.)</td>
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<tr>
<td>56</td>
<td>-do-</td>
<td>123. Drill through and blind holes at an angle using swivel table of drilling machine (10 hrs.)&lt;br&gt;124. Precision drilling, reaming and tapping and Test- Job (15 hrs.)</td>
</tr>
<tr>
<td>Page</td>
<td>-do-</td>
<td>Task Description</td>
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</tr>
<tr>
<td>57</td>
<td>-do-</td>
<td>125. Make Dovetailed fitting and radius fitting. (25 hrs.)</td>
</tr>
<tr>
<td>58</td>
<td>-do-</td>
<td>126. File and fit, combined fit with straight, angular surface with ± 0.02 mm accuracy and check adherence to specification and quality standards using equipment like Vernier calipers, micrometers etc. (25 hrs.)</td>
</tr>
<tr>
<td>59</td>
<td>-do-</td>
<td>127. Drilling and reaming, small dia. holes to accuracy &amp; correct location for fitting. (4 hrs.) 128. Perform drilling using V. block and a clamp. (1 hr.) 129. Make male and female fitting parts, drill and ream holes not less than 12.7 mm. (20 hrs.)</td>
</tr>
<tr>
<td>62</td>
<td>-do-</td>
<td>134. Dovetail and Dowel pin assembly. (20 hrs.) 135. Scrape cylindrical bore. (5 hrs.)</td>
</tr>
<tr>
<td>63</td>
<td>-do-</td>
<td>136. Scrapping cylindrical bore and to make a fit (15 hrs.) 137. Scrapping cylindrical taper bore and check taper angle with sine bar. (10 hrs.)</td>
</tr>
<tr>
<td>64</td>
<td>-do-</td>
<td>138. Make a cotter jib assembly.(25 hrs.)</td>
</tr>
</tbody>
</table>
| 65 | -do- | 139. Hand reams and fit taper pin. (15 hrs.)  
140. Drilling and reaming holes in correct location, fitting dowel pins, stud, and bolts.(10 hrs.) | The various coatings used to protect metals, protection coat by heat and electrical deposit treatments. Treatments to provide a pleasing finish such as chromium silver plating, nickel plating and galvanizing. |
| 66 | -do- | Make different gauges by using standard tools & equipment and checks for specified accuracy. [Different Gauges – Snap gauge, Gap gauge; Specified Accuracy ±0.02mm]  
141. Making a snap gauge for checking a dia of 10 ± 0.02 mm.(25 hrs.) | Gauges and types of gauge commonly used in gauging finished product-Method of selective assembly, „Go. system of gauges, hole plug basis of standardization. |
| 67 | -do- | 142. Scrape external angular mating surface and check angle with sine bar.(15 hrs.)  
143. Scrape on internal surface and check.(10 hrs.) | Bearing-Introduction, classification (Journal and Thrust), Description of each, ball bearing: Single row, double row, description of each, and advantages of double row. |
| 68 | -do- | 144. Practice in dovetail fitting assembly and dowel pins and cap screws assembly.(20 hrs.)  
145. Industrial visit.(5 hrs.) | Roller and needle bearings: Types of roller bearing. Description & use of each. Method of fitting ball and roller bearings Industrial visit. |
| 69 | -do- | 146. Preparation of gap gauges.(15 hrs.)  
147. Perform lapping of gauges (hand lapping only)(10 hrs.) | Bearing metals – types, composition and uses. Synthetic materials for bearing: The plastic laminate materials, their properties and uses in bearings such as phenolic, teflon polyamide (nylon). |
| 70 | -do- | 148. Preparation of drill gauges. (10 hrs.)  
149. File and fit straight and angular surfaces internally.(13 hrs.)  
150. Identify different ferrous metals by spark test(2 hrs.) | , the importance of keeping the work free from rust and corrosion. |
| 19 - 21 | Apply a range of skills to execute pipe joints, dismantle and assemble valves & fittings with pipes and test for leakages. [Range of skills – Cutting, Threading, Flaring, Bending and Joining] | 151. Flaring of pipes and pipe joints. (3 hrs.)  
152. Cutting & Threading of pipe length. (3 hrs.)  
153. Fitting of pipes as per sketch observing conditions used for pipe work. (12 hrs.)  
154. Bending of pipes- cold and hot. (7 hrs.) | Pipes and pipe fitting- commonly used pipes. Pipe schedule and standard sizes.  
Pipe bending methods. Use of bending fixture, pipe threads-Std. Pipe threads Die and Tap, pipe vices. |
| 72 | -do- | 155. Dismantling & assembling – globe valves, sluice valves, stop cocks, seat valves and non-return valve. (25 hrs.) | Use of tools such as pipe cutters, pipe wrenches, pipe dies , and tap, pipe bending machine etc. |
| 73 | -do- | 156. Fit & assemble pipes, valves and test for leakage & functionality of valves. (22 hrs.)  
157. Visual inspection for visual defects e.g. dents, surface finish. (1 hrs.)  
158. Measuring, checking and recording in control chart. (2 hrs.) | Standard pipefitting- Methods of fitting or replacing the above fitting, repairs and erection on rainwater drainage pipes and house hold taps and pipe work. Inspection & Quality control - Basic SPC - Visual Inspection |
| 74-75 | In-plant training / Project work  
1. Key Way Fitting  
2. Lathe Dog  
3. Different Test Piece For Fitter  
4. Radius Form Gauge/ Form Gauge/ Snap Gauge  
5. Square Fitting Alignment  
6. Universal Fitting  
7. Hand Press  
8. Setup assembly of pipes and valves and test for leakage/ functionality | |
| 76-77 | Revision | |
| 78 | Examination | |
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.
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 at corners on part 1 and 2.
• Remove unwanted material by chain drilling, Hack sawing 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.
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 serviceability 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.
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 withstand 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
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.
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>
<thead>
<tr>
<th>Applications</th>
<th>Tools required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loosening and tightening of large dimension bolts during maintenance. High</td>
<td></td>
</tr>
<tr>
<td>torques with moderate accuracy requirements.</td>
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</tr>
<tr>
<td>Assembly of machines screws where speed and handiness are important. Medium</td>
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</tr>
<tr>
<td>accuracy.</td>
<td></td>
</tr>
<tr>
<td>Small screw assembly at low torque and medium high accuracy.</td>
<td></td>
</tr>
<tr>
<td>Assembly of machine screws at low torque and medium to high accuracy.</td>
<td></td>
</tr>
<tr>
<td>Assembly of machine screws and nuts where accuracy requirements are high.</td>
<td>Bolts with limited accessibility.</td>
</tr>
<tr>
<td>Assembly of machine screws where in the tightening process the torque and/</td>
<td>Tool name for application in the Table 1.</td>
</tr>
<tr>
<td>or angle must be monitored for quality control and certification.</td>
<td></td>
</tr>
<tr>
<td>Application where the counting of properly tightened screws in a joint is</td>
<td></td>
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<tr>
<td>essential for product quality control.</td>
<td></td>
</tr>
<tr>
<td>Assembly where in the tightening process control to a high level of accuracy</td>
<td></td>
</tr>
<tr>
<td>is necessary.</td>
<td></td>
</tr>
<tr>
<td>Applications where articulated arms are used to support the reaction torque</td>
<td></td>
</tr>
<tr>
<td>for multiple spindle tightening and for automatic systems.</td>
<td></td>
</tr>
<tr>
<td>For maximum mobility and where the air hose or electric cable would limit</td>
<td></td>
</tr>
<tr>
<td>access or pose a safety risk from a jammed cable.</td>
<td></td>
</tr>
</tbody>
</table>
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.
ASSEMBLY

ASSEMBLY SLIDING FIT USING KEYS, DOWEL PINS AND SCREWS

CODE NO: FIN31121E2
**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 Ø 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 Ø 6 mm hand reamer with tap wrench without disturbing the position of the job.
- Clean the reamed hole and fix Ø 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 Ø 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 Ø 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.
- Apply thin coat of oil and preserve it for evaluation.

**Skill Sequence**

**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 tri 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 tri square, insert the part 4 in between gap and then clamp it by using parallel clamps.

---

**Fig 1**

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**Capital Goods and Manufacturing : Fitter (NSQF Level-5) : Exercise : 3.1.121**
File & fit angular mating surface within an accuracy of \( \pm 0.02 \) 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 \( \pm 10' \) accuracy
- file part 1,2,3 maintaining the accuracy of \( \pm 0.02 \) for fitting
- assemble the part 1,2 & 3.
- finish and de-burr.

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1 65 ISF 6.75  Fe310  3
1 35 ISF 6 - 75  Fe010  2
1 35 ISF 6 - 75  Fe010  1  S1:1/22

SCALE : 1:1

FILE AND FIT ANGULAR MATING SURFACE WITHIN AN ACCURACY OF \( \pm 0.02 \) mm & 10 MINUTES ANGULAR FITTING

TOLERANCE : \( \pm 0.02 \)
TIME: 25 Hrs

CODE NO: FIN01122E1
Job Sequence

- Check the raw material for its size.
- File surface and right angle and mark off part 1, 2 & 3 with vernier height gauge and vernier bevel protractor.
- Punch on the marked lines.
- Remove excess materials by hacksawing & chain drilling.
- File part 1, 2 & 3 with a 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 |
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.
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 Ø 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 Ø 10 mm to full depth.
• Deburr and clean the job.
• Apply thin layer of oil and preserve it for evaluation.

Skill Sequence

Objective: This shall help you to
• angular drilling of through & blind holes.

Fig 1

Fig 2
Objectives: At the end of this exercise you shall be able to
• file and finish the job to the overall size.
• chamfer all the corners
• drill, ream & tap at specified location
• check using plug gauge & thread plug gauge
• finish and deburr.
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 evaluation.

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,

\[
\text{drill diameter} = \text{reamed hole size} - (\text{undersize} + \text{oversize})
\]

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.

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)

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.
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.
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 overall 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 Ø 3 mm in both the parts 1 & 2 and also chain drill in part 2.

Part - 1

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

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

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

- Hacksaw and 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.

Part - 2

- Hacksaw on one side of dovetail to remove excess metal as shown in Fig 5.

- Hacksaw and cut off along the chain drilled holes using web chisel and ball pein hammer and remove as shown in 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

- Hacksaw and remove the excess metal and file the half round profile to size and check it with radius gauge Fig 7.
• Match part 1 and 2 to fit both dovetail and half round profile as shown in Fig 8 and 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 and check adherence to specification and quality standards using equipment like vernier calipers, micrometers etc.,

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.
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 witness marks.
• Chain drill and drill relief holes of $\Phi$ 3 mm in part 1 & 2 as shown in Fig 1 to 4.

Part 1

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

Part 2

• Hacksaw, chip and remove the excess material as shown in Fig 4.
• Drill relief holes $\Phi$ 3 mm as shown in Fig 4.

• File to size to shape maintaining accuracy of $\pm$ 0.02 mm.
• Check the size with vernier caliper.

• 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.

• Similarly, hacksaw on other two potion of part 1 to remove excess metal and file to shape to an accuracy of $\pm$ 0.02 mm Fig 3.
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 \( \pm 0.02 \) 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 sawing 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 Ø 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 Ø 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.
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 hole centre to the drilling machine spindle.
- Clamp the job rigidly.
- Set the proper rpm.
- Drill the hole.
- Place the job on the ‘V’ block which is placed on the drilling machine table.
- Loosen the ‘U’ clamps.
- Rotate and align the job centre marked in the face perpendicular to the drilling machine table surface.

Use two ‘V’ blocks and clamp to support long round rods rigidly while marking. (Fig -1)
Make male and female fitting parts, drill and ream holes not less than 12.7mm

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.
**Job Sequence**

- Check the raw materials for its size.

**Part 1**
- File Part 1 to overall size $58 \times 58 \times 5$ 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 $\odot 12.7$ mm through hole for reaming.
- Ream $\odot 13$ mm hole with reamer.
- Cut and remove excess materials and file the profile of the job maintaining necessary accuracy of $\pm 0.02$ mm.

- Check the size with the vernier caliper.
- Check the flatness and squareness with try square.
- 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.
- Match part 1 and part 2 as per job drawing
- Apply thin oil and preserve it for evaluation.
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 Ø 3 mm
- chain drill hole and remove excess metal
- file to size and match as per drawing
- finish and deburr.

Make sliding diamond fitting

SCALE: NTS

TOLERANCE: ±0.02
TIME: 20H/s

CODE NO. FIN21130E1
Job Sequence

- Check the raw material for its size.
- File and finish part A and part B for the overall size maintaining parallelism and perpendicularity.
- Mark part A and part B with a vernier height gauge as per drawing.
- Punch witness marks and relief hole marks.
- Drill relief holes of $Ø$ 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.
- 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.
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 using try square.
• 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 with standard set of roughness sample.

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.

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)

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.
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.

NOTE: REFER PART DRAWINGS

<table>
<thead>
<tr>
<th>NO.OFF</th>
<th>STOCK SIZE</th>
<th>SEMI-PRODUCT</th>
<th>MATERIAL</th>
<th>PROJECT NO.</th>
<th>PART NO.</th>
<th>EX. NO.</th>
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<td>STEPPED KEY</td>
<td>Fe310</td>
<td>3</td>
<td>3.1.132</td>
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</tr>
</tbody>
</table>

TOLERANCE: ±0.02
TIME: 20Hrs

CODE NO: FIN31132E1
Job Sequence

- Check the raw material using steel rule.
- File and prepare part 1, 2 and 3 for the overall 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 a four jaw chuck in lathe.
- Turn face turning on ends.
- Turn $\Theta$ 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 $\Theta$ 6 mm twist drill in tail stock through drill chuck and drill pilot hole.
- Enlarge previously drilled hole.
- Drill and bore $\Theta$ 25 mm through hole.
- Chamfer the $\Theta$ 25 mm hole end to 2 mm x 45°.
- Reverse the job and hold it in lathe chuck.
- Plain turn the job to $\Theta$ 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.
- Face turn on one of the job.
- Chamfer the end to 2 mm x 45°.
- Plain turn the job of $\Theta$ 25 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.
Capital Goods and Manufacturing  
Fitter - Assembly - 1  

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.

PART - 1

PART - 2

LAPPING ON HOLE

LAPPING ON CYLINDRICAL SURFACE

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SCALE: 1:1

LAPPING HOLES AND CYLINDRICAL SURFACES

TOLERANCE: ±0.02
TIME: 5 Hrs
CODE NO: FIN31133E1
Job Sequence

- Prepare the bore in part 1 as per drawing.
- Hold the job in bence vice.
- Select a adjustable cylindrical lap for lapping hole
- Change 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 remove the job from lap holding 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 bence 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). Adjustable lap have interchangeable sleeves made of copper. Laps are sometimes provided with holes which can hold the lapping compound (Fig.2).

[Fig 1]

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 2]
The lap should not be removed from the hole while lapping, and should travel the full length of the bore Fig 4.

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.

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
• mark dimensions with vernier height gauge
• 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.

SECTION - AA

SECTION - BB

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TOLERANCE: ±0.02mm  TIME: 20Hrs

CODE NO: FGM31134E1
PART 3

SECTION - CC

ASSEMBLY

4 OFF - Ø5 STEEL DOWEL PIN
PUSH FIT

2 OFF - M6 CHEESE
HEAD SCREW

'C'

DOVETAIL AND DOWEL PIN ASSEMBLY

CODE NO: FIN31134E2
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 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 blocks.
- Check the squareness of assembly using trysquare.
- Hold the assembly in drilling machine table without disturbing the setting.
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.

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TOLERANCE: ±0.02mm  TIME: 5hrs

SCRAPE CYLINDRICAL BORE

CODE NO: FIN31135E1
**Job Sequence**

- Cut the raw material to its size.
- File to size 73 x 73 x 9 mm and check with vernier caliper.
- Check the flatness and squareness with try square.
- Mark and punch the centre.
- Drill the pilot hole Ø 6 mm
- Enlarge a hole Ø 12, Ø 25, Ø 40 and Ø 49 in sequence.
- Ream the hole Ø 50 mm using reamer.
- Hold the Ø 50 mm cylindrical test bar in a bench vice
- Apply prussion blue on cylindrical surface of a test bar Ø 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 around scraper.
- Clean the scraped surface with soft cloth.
- Check the bore by using three point internal micrometer.
- Check the scraped hole by inside micrometer.
- 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 mm
- measure diameter of through holes
- check cylindricity and roundness of bore using three point internal micrometer.

- Select the correct size of three point internal micrometer.
- Select the proper zero setting ring 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.
Scraping 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.
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 $\varnothing 50$ g6 as a master gauge for checking scraped hole)

Part: 2
- Mark location of centre
- Drill pilot hole and enlarge, the drilled hole to $\varnothing 49$ mm.
- Ream the drilled hole $\varnothing 50$ using adjustable reamer.
- Apply precision blue on cylindrical surface of a $\varnothing 50$ mm plug gauge.
- Insert and rotate plug gauge in a hole smoothly to find high spots.
- Hold the job on bench vice.
- Scrap high spots with by using half round scraper.

Assembling Technique:
- Clean the scraped surface with soft cloth.
- Fit the master test piece to the scraped hole and rotate smoothly for testing.
- Fit the shaft into the cylindrical hole as per drawing and rotate it freely.
- Apply a little oil and preserve it for evaluation.

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.

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.

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

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.
Objective: 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.
TASK - 2

DIAL GAUGE IN FIRST POSITION

DIAL GAUGE MOVED TO SECOND POSITION

SINE BAR

SLIP GAUGE

DATUM SURFACE

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CHECK TAPER ANGLE WITH SINE BAR

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CODE NO: FIN31137E2
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 ø 28 mm.
- Set the tool in tool post.
- Turn the compound slide to an angle of 1° 30' maintaining major diameter ø 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.
- 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.

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

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

\[
\sin \theta = 0.1736
\]
\[
\therefore \theta = 10^\circ
\]
\[
\therefore \text{Angle of taper plug} = 10^\circ
\]
Make a cotter gib 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

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<td>Ø7 3/4 BORE AT 90° TO Ø13</td>
<td>Ø6 DRILL HOLE</td>
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SCALE 1:1

MAKE A COTTER JIB ASSEMBLY

TOLERANCE: ±0.02
TIME 29Hrs

CODE NO: FIN31138E1
Job Sequence

- Check the raw materials for its sizes as per drawing.

**Part 1**
- File part 1 raw material to size 60.3 x 60.3 x 9.5 mm maintaining the dimensional tolerance as per drawing, flatness and squareness Fig 1
- Check the size with vernier caliper and flatness and squareness with try square.

**Part 2**
- File part 2 raw materials to size 60.3 x 22.22 x 9.5 mm of two pieces and apply marking media and mark 60° angular line using vernier bevel protractor and also mark the location of dowel hole and cheese head screw assembly hole.
- File 60° angular surface with flat file (using base angle and second angle grades of side) and check the 60° angle with vernier bevel protractor maintaining the angular tolerance ± 5 minute accuracy.

**Part 3**
- File part 3 raw material to size 60.3 x 26.9 x 9.5 mm and apply marking media and mark the 60° angular line using vernier bevel protractor and also mark the location of handle fixing hole.
- File 60° angular surface with flat file and check the 60° angle with vernier bevel protractor maintaining the angular tolerance ± 5 minute accuracy.

**Part 4 and Part 5**
- Check the raw material roundrod for its size as per drawing.
- Hold the job in centre lathe and turn the job as per shape and size maintaining the dimensional tolerance ± 0.02 mm
- Place part 2 and 3 on part 1, assemble and clamp the parts with parallel blocks and check the squareness of assembled parts Fig 5.
- Hold the assembly in a drilling machine table with machine vice.
- Keep the parallel blocks under the assemble for proper setting and handling the job.
- Fix a centre drill in drilling machine and drill 1 or 2 mm depth centre drilling on part 2 and part 3 in the place of dowel pin, cheese hand screw and handle assembly holes.
• Remove centre drill and fix Ø 4.8 mm drill in drilling machine and drill through hole in dowel pin locations assembly.

• Fix Ø 5 mm reamer in tap wrench and ream the drilled hole without disturbing the assembly. (Use oil while reaming).

• Fix a dowel pin Ø 18 x 5 mm in the reamed hole of dowel pin assembly locations.

• Similarly fix Ø 7 mm drill and drill through hole in cheese head screw assembly location.

• Remove Ø 7 mm drill and fix Ø 12 x 7 mm counter bore tool with pilot in drilling machine and counter bore to depth of cheese head screw head thickness.

• Cut M 6 internal thread in part 1.

• Remove deburrs from threaded hole.

• Fix cheese head screw in the place of threaded hole.

• Similarly repeat the above procedures in part 2 in another piece and fix another dowel pin and cheese head screw.

• Dis assemble the assembly setting and separate all the parts.

• Drill Ø 5.8 mm in part 3 in the location of colter gib fixing.

• Fix Ø 5.8 mm reamer and ream the drilled hole to fix colter gib.

• Finish all the surfaces and remove burrs on all the corners of the parts of assembly.

• Reassemble the parts 1 and 2 along with dowel pins and cheese head screws.

• Fit part 3 in dovetail shaft along with colter gib and slide it Fig 6.

• Apply little oil and preserve it for evaluation.
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 | 3.1.139 |
| 2 | Ø6-20 | DOWEL PIN | Fe310 | – | 4 | 3.1.139 |
| 1 | SQ 25-27 | INSERT | Fe310 | – | 3 | 3.1.139 |
| 1 | 65 ISF 10-65 | BASE PLATE | Fe310 | – | 2 | 3.1.139 |
| 1 | 65 ISF 10-65 | TOP PLATE | Fe310 | – | 1 | 3.1.139 |

NO.OFF | STOCK SIZE | SEMI-PRODUCT | MATERIAL | PROJECT NO. | PART NO. | EX. NO. |

2 | 1 | 1 | 1 | 1 |

SCALE 1:1 | TOLERANCE ±0.02mm | TIME 15Hrs |

HAND REAMS AND FIT TAPER PIN

CODE NO: FIN31136E1
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 centre 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](image1.png)

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

![Fig 2](image2.png)

- 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 dowel pin in the assembly through push fit as per drawing.
- Fix \( \varnothing \) 6.0 mm drill in drilling machine and drill a through hole in the place of cheese head screw assembly.
- Fix \( \varnothing \) 10 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 \( \varnothing \) 3 mm drill in drilling machine and drill relief holes as per drawing.
- Fix \( \varnothing \) 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](image3.png)

- Dis assemble the setting from drilling machine table and chip and remove the unwanted 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
• 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 M6 internal thread to suit bolt and stud
• assemble as per drawing.
DRILLING AND REAMING HOLES IN CORRECT LOCATION, FITTING DOWEL PINS, STUD AND BOLTS

CODE NO: RIN31140EZ
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

- Fix Ø 5.8 mm drill in drilling machine and drill through holes and ream the holes of Ø 6 mm reamer in part 1 and 2.
- Clean the reamed hole with soft cloth and fit Ø 6 mm dowel pin.
- Similarly drill, ream and fit Ø 6 another dowel pin with the same setting in part 1 and 2 as shown in Fig 1.
- Then fix Ø 5 mm drill in drilling machine and drill through hole for M 6 hexagon bolt assembly.
- Similarly drill Ø 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.

- 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 Ø 5.8 mm drill in drilling machine and drill through hole ream Ø 6 mm for dowel pin assemble with part 1 and 3.
- Fit Ø 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 Ø 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.
- 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.
Making a snap gauge for checking a dia. of 10 ± 0.02mm

Objectives: At the end of this exercise you shall be able to
• file to overall size as per drawing
• mark the profile as per drawing and punch with measurements
• chain drill chip and file profile as per drawing
• turn a round to size and shape
• check the round rod into GO end and NO GO end.
Job Sequence

Snap Gauge:
- Check the raw material for its size
- File the raw material to size 75 x 48 x 9 mm maintaining flatness and squareness
- Check the flatness and squareness with try square.
- Apply marking medium cellulose lacquer on the surface of the job.
- Mark all the dimension lines as shown in job drawing Part – 1
- Punch witness marks on the marked lines.
- Chain drill and remove excess metal by chipping and sawing.
- File and finish the profile as per given in the job drawing maintaining the dimensional accuracy of ±0.02mm.
- Check the measurement with vernier caliper
- Finish surface and remove burrs in all corners of the job.

Round Rod:
- Hold the round in a centre lathe with three jaw chuck.
- Turn the round rod to size fit of ø 10g6 (-5, -14) x 60 mm long maintaining the dimension between 9.995 mm and 9.986 mm.
- Chamfer both the ends of round in lathe.
- Check the round rod in “snap gauge”.
- Apply thin coat of oil to preserve and for evaluation.

Skill Sequence

The BIS system of limits and fits- reading the standard chart

Objective: This shall help you to
- refer to the standard limit system chart and determine the limits of sizes.

The standard chart covers sizes upto 500 mm (I.S. 919 of 1963) for both holes and shafts. It specifies the upper and lower deviations for a certain range of sizes for all combinations of the 25 fundamental deviations, and 18 fundamental tolerances.

The upper deviation of the hole is denoted as ES and the lower deviation of the hole is denoted as EI. The upper deviation of the shaft is denoted as es and the lower deviation of the shaft is denoted as ei.

NOTE: “ES” is expanded as ECART SUPERIEUR and “EI” as ECART INFERIEUR.

Determining the limits from the chart

Note whether it is an internal measurement or an external measurement.

Note the basic size.

Note the combination of the fundamental deviation and the grade of tolerance.

Then refer to the chart and note the upper and lower deviations which are given in microns, with the sign. Accordingly add or subtract from the basic size and determine the limits of size of the components.

Example

30 H7 (Fig 1)

It is an internal measurement. So we must refer to the chart for ‘holes’.

The basic size is 30 mm. So see the range 30 to 40.

Look for ES, and EI values in microns for H7 combination for 30 mm basic size.

It is given as

Therefore, the maximum limit of the hole is 30 + 0.025 = 30.025mm.

The minimum limit of the hole is 30 + 0.000 = 30.000mm.

Refer to the chart and note the values of 40 g6.

The table for tolerance zones and limits as per IS 2709 is attached.
Scrape external angular mating surface and check angle with sine bar

Objectives: At the end of this exercise you shall be able to
- file to flat and square
- mark as per drawing and punch witness marks
- prepare Part 1 and 2 as per drawing
- check angle with sine bar.
Job Sequence

- Check the raw material for its size.
- File to flatness and squareness to overall size.
- Mark dimensional lines as per drawing and punch witness marks.
- Cut off the material into two pieces (part – 1 and part – 2) by hackawing as shown in Fig -1

File part – 1 to size and shape maintaining the dimensional accuracy ± 0.02mm

- Check the dimensions with vernier caliper.
- Check the angle 19° 17’ with vernier bevel protractor.
- Similarly file part – 2 to size and shape and also to angle 19° 17’
- Apply prusion blue evenly on the surface plate to check high spot on angular surfaces.
- Place part – 1 and part - 2 angular surfaces on surface plate and move gently.
- Take the job from the surface plate and notice the high spot (prusion blue spotted marks) on angular surfaces.
- Hold the job in a bench vice, scrap and remove the high spots with a flat scraper.
- Repeat the process until the prusion blue cover the entire angular surfaces of part – 1
- Similarly scrape part – 2 and maintain the angular surface without high spot and angle 19° 17’.

Calculation of angle

\[
\tan \theta = \frac{\text{opposite side}}{\text{adjacent side}} = \frac{35}{100} = 0.3500
\]

\[\therefore \theta = 19°17'20" \text{ (as per trigonometric table)}\]

- Clean the surface plate, sine bar and slip gauge with soft cloth.
- Select the slip gauge to the height of 35 mm
- Set the part – 1 in sine bar and clamp it properly.
- Fix the dial test indicator in the stand.
- Set the dial test indicator plunger on the angular surface of the job.
- Set the dial test indicator pointer in ‘zero’ position
- Wring the slip gauges under the sine bar roller.
- Move the dial test indicator from one end to other end and check the parallelism of the angular surface.
- If the dial test indicator pointer does not move plus (or) minus side and stand still in zero position means, there is no deviationin the angular surface of job.
- Instead of that, the dial test indicator pointer moves plus (or) minus side means there is a deviation in the angular surface of the job.
- If you notice any deviation, correct the parallelism of the surface of the job by using suitable slip gauge.
- Dismantle the setting, clean all the instruments and keep it in proper place.
- Make part – 1 and part – 2 angular surface and apply thin coating of oil and preserve it for evaluation.
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 triangle 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 gauges 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.

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 angle 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.
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 selected slip gauges under the roller 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.

Move the dial to the other end of the component (second position). If there is any difference 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 calculated and the deviation, if any, will be the error.

Method calculating the slip gauge height

Example Fig 3

Exercise 1

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

\[ \sin \theta = \frac{a}{c} \]

\[ \theta = 25^\circ \]

\[ a = CS \sin \theta \]

\[ = 200 \times 0.4226 \]

\[ a = 84.52 \text{mm} \]

The height of the slip gauge required is 84.52 mm.

The value of sine \( \theta \) can be obtained from mathematical tables. (Natural trigonometrical functions).

Tables are also available with readily 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.

\[ \sin \theta = \frac{a}{c} \]

\[ = \frac{84.52}{200} \]

\[ \sin \theta = 0.4226 \]

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 ___________________________________
Scrape on internal surface and check

Objectives: At the end of this exercise you shall be able to
• file to size as per drawing
• mark and punch to the dimensions
• chain drill and chip excess metal
• file profile to shape and size to an accuracy of ± 0.02mm
• scrape and remove high spots on internal surface.
**Job Sequence**

**Scrape on internal surface and check**

- Check the raw material for its size.
- File metal to over all size 90 X 48 X 14mm and check the size with Vernier caliper.
- Check Flatness and squarenessness with try square.
- Apply marking media and mark as per drawing and punch witness marks.
- Chain drill holes to remove Excess metal as shown in Fig 1.

- Cut and remove the chain drilled portion by chipping.
- File the chipped portion to profile and check with radius gauge and size with Vernier Caliper.
- Hold the test material $\phi$ 60mm on bench vice and clean with soft cloth.

**Use banian cloth / mull cloth for cleaning.**

- Apply Prussion blue on the cylindrical surface of material.
- Clean and place the job’s curved portion on (bearing surface) on test material and rotate it gently to find high spots. (Fig 2).

- Hold the job in bench vice. Scrape and remove the high spots with half round scraper (Fig 3).

- Similarly, scrape till high spots are spreaded evenly all over the entire curved surface of the job.
- Finish and remove the burrs in all corners of the job.
- Apply little oil and preserve it for evaluation.

**Caution:**

- Always use scraper with handle.
- Protect the cutting edge of a scraper with a rubber cover when not in use.
- Apply oil, grease on the cutting edges when not in use and keep it in safe place.
Skill Sequence

Objective: This shall help you to
• scrape and test curved surfaces

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 facilitate the movement of the scraper in the required direction 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.

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

After each pass, change the direction of cutting. This ensures a uniform surface Figs 3 & 4.

Use a master bar to check the correctness of the surface being scraped Fig 5.

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

Fig 1

Fig 2

Fig 3

Fig 4

Fig 5
Practice in dovetail fitting assembly and dowel pins and cap screws assembly

Objectives: At the end of this exercise you shall be able to
- mark dimensions with a Vernier height gauge
- file the parts 1, 2, and 3 to size
- drill ream and tap at correct locations
- counterbore to required depth
- assemble the parts 1, 2 & 3 with dowel pins and cap screws.
### PART 1

- M6-2 TAPPED HOLE
- Ø6 H7-4 DOWEL PIN HOLES

### PART 2

- Ø6 H7-3 DOWEL PIN HOLE
- Ø6.2 C BORE TO SUIT M6 CAP SCREW
- 2 NOS

### PART 3

- 60

---

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**Scale:** 1:1

**Practice in Dovetail Fitting Assembly and Dowel Pins and Cap Screws Assembly**

**Deviation:** ± 0.02

**Time:**

**Code No:** FSN214462

---

*Capital Goods and Manufacturing: Fitter (NSQF Level-5): Exercise: 3.2.144*
Job Sequence

- Check the raw material for its size, part 1, 2, & 3 as per drawing.

Part 1
- File to size and square. (Fig 1).

Part 2
- File to size and square. (Fig 2).
- Mark 60° angle using Vernier bevel protector in two pieces. (Fig 3).

Part 3
- File to size and square to 30x60x20 mm (Fig 6).
- Mark lines as per drawing with vernier height gauge and angle to 60° with vernier bevel protector. (Fig 7).
- Cut and file the angular surface to flat and 60° angle and check the angle with Vernier bevel protector. (Fig 4)
- Mark the holes as per drawing in two piece (Fig 5).
• Cut and remove the excess metal of hatched portion in one side by sawing and file to size, shape and angle to 60°. (Fig 8)

• Similarly, repeat the above process in other side of the job.

• Check the size with vernier caliper and angles with vernier bevel protractor (Fig 9).

• Place part 2 on part 1, assemble together and clamp the parts with parallel clamp and check the squareness of assembled parts with try square. (Fig 10).

• Hold the assembly in a drilling machine table with machine vice.

• Keep parallel blocks under the assembly, while holding in machine vice for proper seating and levelling the job.

• Fix a centre drill in drilling machine and drill 2 to 3 mm depth, centre drilling on part 2 in the place of dowel pin and cap screw assembly.

• Remove centre drill and fix 5.8mm drill in drilling machine and drill a through hole in the place of dowel pin assembly.

• Fix 6mm reamer in tap wrench and ream the drilled hole without disturbing the assembly (use plenty of oil while reaming).

• Fix a dowel pin 6 X 18mm in the reamed hole of dowel pin assembly.

• Similarly, repeat the above drilling and reaming procedures in the other end of the same job without disturbing the assembly and fix another dowel pin in the reamed hole.

• Fix 6 mm drill in drilling machine and drill a through hole in the place of cap screw assembly.

• Remove 6 mm drill and fix 10 X 6 mm counter bore tool in drilling machine and counter bore to the depth of cap screw head thickness in part 2.

• Dismantle the setting.

• Hold counter sink tool in drilling machine and chamfer the cap screw assembly tapping hole ends in both sides in part 1.

• Cut, four M6 internal thread in part 1.

• Clean burrs from threaded hole.
• Reassemble the dismantled setting and fix dowel pins in reamed holes and fix M6 X 18mm cap screw in a threaded hole in part 1 and 2 assembly.
• Place and assemble other two pieces of part 2 and part 3 on part 1 and clamp them with parallel clamp and check the squareness of assembled parts. (Fig 11).

Follow the above working steps, given in the previous assembly of part 1 and 2 and complete the different operations and fix another two dowel pins and another to cap screws.

Dismantle the setting of assembly and separate all the parts.

Reassemble the parts 1 and 2 along with dowel pins and cap screws. Check the dovetail slot gap size with slip gauge. If dovetail slot gap size is not correct, correct the gap size by filing in part 2. (Fig 12). While filing in part 2. Dismantle the assembly and file to size.

• Place 10mm two precision rollers in dovetail slot and calculate the dovetail slot length. If dovetail slot length is not correct, correct the length size by filing in part 2. (Fig 13).

Fix part 3 in dovetail slot and slide it. (Fig 14).

Dismantle and separate all the parts and finish all the surfaces and remove burrs on all the corners of the assembly.

Reassemble all the parts and fit part 3 in dovetail slot and slide it.

Apply a little oil and preserve it for evaluation.
Skill Sequence

DETERMINING INTERNAL DOVETAIL ANGLE USING ROLLERS AND SLIP GAUGES

Objectives: This shall help you to
• use of precision balls and rollers.
• calculate internal dovetail angle using rollers and slip gauges.

Use of precision balls and rollers

There are situations where measurements of components cannot be taken directly. A typical example of this is a dovetail (internal and external).

In such cases it is possible to calculate the size and taper accurately from the measurement taken over the balls or rollers placed between standard measuring instruments and the component. (Fig 1)

The purpose of the balls or rollers is to provide point or line contact in a known position.

Gap between the rollers can be measured using vernier caliper.

Fig 1 shows how the distance between the rollers is measured with a vernier caliper. It also shows that the point of contact does not lie in the plane of measurement.

Calculating taper angle of internal parallel dovetail

After cleaning the dovetail and the matched pair of precision rollers, the rollers are positioned in such a way that the rollers will contact the angular faces as shown in Fig 2.

The gap between the rollers can be measured using a slip gauge or vernier caliper.

In the triangle (shaded) (Fig 3)

\[ \frac{\tan \frac{\theta}{2}}{r} = \frac{r}{B} \]  
\[ c = A + 2r + 2B \]  
\[ 2B = C - A - 2r \]  
\[ B = \frac{C - A - 2r}{2} \]  
\[ \frac{\tan \frac{\theta}{2}}{B} = \frac{r}{C - A - 2r} \]  
\[ = \frac{2r}{C - A - 2r} \]

(The value of C,A,r, are known. Hence the angle \( \frac{\theta}{2} \) can be calculated.)

This is the half angle of the dovetail.

Example

Calculate the internal dovetail angle of a workpiece as per data given in the Fig 4.
Classroom Assignment (Fig 5)

Calculate the distance C of the dovetail if the diameter of the roller is 20 mm, angle is 60° and the distance between the rollers is 2.68 mm.

\[
\tan \theta = \frac{\text{Oppositeside}}{\text{Adjacentside}}
\]
\[
\tan \frac{\theta}{2} = \frac{r}{B} = \frac{3}{8}
\]
\[
\frac{3}{8} = 0.375
\]
\[
\tan \frac{\theta}{2} = 20^\circ30'
\]

Tan \( \theta \) or dovetail included angle = 41°...Ans
Fitter - Gauges

Industrial visit

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

•
•
•

NOTE: INSTRUCTOR SHALL ARRANGE
INDUSTRIAL VISIT
Preparation of gap gauges

Objectives: At the end of this exercise you shall be able to
• file flat and square
• mark the profile as per drawing
• drill relief holes, chain drilling and hacksawing
• chip, file to size and profile as per drawing
• file GO end and NO GO end to size
• check the gap GO end and NO GO end with slip gauge.

![Diagram of gap gauges]

---

1  75 BF10-40  -  Fe 310  -  B  3.2.146
1  60 BF10-40  -  Fe 310  -  A  3.2.146

NO.OFF  STOCK SIZE  SEMI-PRODUCT  MATERIAL  PROJECT NO.  PART NO.  EX. NO.

SCALE: 1:1

PREPARATION OF GAP GAUGES

TOLERANCE: ±0.02 mm  TIME 15mins

CODE NO.  F02146E1
Job Sequence

- Check the raw material for its size.
- File metal to size as per drawing.
- Apply marking media on part A and B as per drawing.
- Mark the profile and punch witness marks.

Part A

- Hold part A in drilling machine table.
- Fix Ø 8mm in drilling machine spindle and drill two relief holes as shown in Fig 1.

- Hold part A in bench vice, cut and remove the hatched portion of excess metal on one side and file the same portion to size maintaining the accuracy of ± 0.02 mm Fig 2.

- Similarly, following the above job sequencies on the other side of the job, cut and remove the excess metal and file to size Fig 3.

Part B

- Hold part B in drilling machine table and drill Ø 8 mm relief holes as shown in Fig 5.

- File radius 7mm as per drawing and check with radius gauge Fig 4.
• Chain drill, hacksaw, chip and remove the excess metal in part B as shown in Fig 6.

• File the excess metal in internal portion of part B to size and shape and check the size with vernier caliper.

• Cut and remove the excess metal in outer surface of the part B and file to size and shape as shown in Fig 7.

• Match part A and part B as shown in Fig 8.
Perform lapping of gauges (hand lapping only)

Objectives: At the end of this exercise you shall be able to
• file flat and square
• check the flatness and squareness
• mark profile as per drawing
• chain drill to remove excess metal
• file Go - end and No go - end to size
• check the gap Go end and No go end with slip gauge
• perform lapping on surface of the gauge.
Job sequence

- Check the raw material for its size.
- File raw material to size 73 X 73 X 9 mm and check the size with Vernier caliper.
- Check the flatness and squareness with try square.
- Apply marking media and mark the profile as per drawing.
- Punch witness marks.
- Chain drill to remove excess metal, as shown in Fig 1.

Lapping

- Select a lapping plate made of closed grain cast iron.
- Charge the lapping abrasive mixed with oil on lapping plate.
- Wash off the surplus oil and abrasive on the lapping plate.
- Place the job on lapping plate.
- Rub the work against a lap charged with a lapping compound.
- Apply light pressure while lapping.
- Repeat the above procedure to lap in other surface of the job.
- Apply oil and preserve it for evaluation.

- Lapping compound consists of abrasive particles suspended in a vehicle such as oil, paraffin, grease etc.
- Lapping can be carried out either in wet and dry condition.

Cut and remove the excess metal by hacksawing and chipping.

File the profile to size and shape maintaining accuracy of ± 0.02mm.

Mark the distance GO end 38 mm maximum limit of size.

File NO GO end size to 37.991 mm minimum limit of size.

File ‘V’ notch at GO end and NO GO end meeting line.

Finish the surface and remove the burrs on the corners of the job.

Check GO end and NO GO end using slip gauge Fig 2.
Preparation of drill gauges

Objectives: At the end of this exercise you shall be able to
- file thin sheet metal to size.
- lay out on sheet metal as per drawing
- file angular surface to an accuracy of ± 0.05"
- file and finish the gauge to the shape and size as per drawing
- check the drill lip length and angle in drill gauge.
Job Sequence

- Check the material size as per drawing
- File the metal to size 115 x 50 x 3 mm and check the size with vernier caliper
- Check the flatness and squareness with try square
- Mark the dimensions as per drawing with vernier height gauge
- Punch the witness marks Fig:1

Fig 1

- Saw and remove excess material by hacksawing (Fig:2)
- Make three relief slots as per drawing by hacksawing.

Ensure that about 1 mm material is left from the witness marks by hacksawing for filing and finishing.

Fig 2

- File and finish 120° angle using triangular file and needle file.
- File and finish 31° angle with reference to 50 mm width side using flat triangular area needle file. (Fig 3)

Fig 3

- File and finish 121° angle with flat triangular and needle file.
- File and finish 60° and 55° angle flat triangular and needle file.
- Measure the dimensions with vernier caliper measure the angles with vernier bevel protractor.
- Mark the graduation as per drawing with a vernier height gauge.
- Deepen the graduations with a carbide tool bit held in a vernier height gauge.
- Finish and deburr all the surfaces.
- Check the drill angle and lap depth of a drill
- Apply little oil and preserve it for evaluation.

Note:

Hold the metal sheet in bench vice along with wooden plant and file the sheet thickness to size (Fig:4)

Fig 4
Skill Sequence

Drill angle grinding and checking with drill gauge

Objectives: This shall help you to
• grind setting angle of a drill and cheese with drill gauge.

A drill will lose the sharpness of its cutting edges due to continuous use, and improper use of drills spoil the cutting edges.

Spoiled or blunt cutting edges of the drills must be sharpened on a grinder.

Check the grinding wheel for loading, glazing, trueness and cracks. Call your instructor for advice. Dress and true the wheel if necessary.

Protect your eyes either with goggles or by lowering the eye protecting shield near the tool rest and adjust the tool rest 2 mm closer to the wheel, if necessary.

Switch on the grinder

Hold the shank of the drill lightly between the thumb and the forefinger, and with the other hand hold the portion near the point Fig 1.

This turning movement is not necessary for smaller dia. drills.

While swinging down, apply a slight forward motion. This will help to form the clearance angle.

While swinging and turning the drill make sure you do not grind the other cutting edge.

All movements of the drill in angular turning, swinging and forward movements, should be well coordinated. They should result in one smooth movement to produce a uniformly finished surface.

Repeat the process to re-sharpen the other cutting edge.

Check both the cutting edges with a drill angle gauge, for correctness of the lip angle and equality of the lip lengths Fig 5 and 6.

Check the lip clearance angle in Fig 5 visually. The angle should be between 8° to 12°.
When you are satisfied correct equal angle and equal lip length. Drill a hole in a scrap metal. Before drilling confirm correct drill speed (r.p.m) use cutting fluid.

Verify the condition of the hole while drilling. Did the drill chatter? If chattering happened, this could be caused by too much lip clearance. If the hole is over size by more than 0.12 to 0.25 mm then check lips lengths for uneven or the lip angles for uneven.
Objectives: At the end of this exercise you shall be able to
• file and finish part 1 & 2 as per dimensions keeping straight
• file angle tolerance of 10 minutes and angle face tolerance of ± 0.02mm
• to remove internal material by drilling & filing
• assemble part 1 & 2 with a sliding fit.
Job Sequence

Part: 2

- Check the raw material for its size.
- File to size and check for flatness and squareness.
- Mark all dimensions and angle on work piece using vernier height gauge and vernier bevel protractor.
- Punch on the marked lines.
- File and finish the part as 28 x 25 x 40 mm and angle to 60°.

Part: 1

- Check the raw material for its size.
- File to size and check for flatness and squareness.
- Mark all dimensions and angle on work piece using vernier height gauge and vernier bevel protractor.
- Punch on the marked lines.
- Drill relief holes of Ø 3 mm on all corners.
- Remove unwanted internal material by drilling and using square and triangular files.
- Angular edges to be finished with triangular file.
- Straight edges to be finished with safe edge file.

\[
\tan 60° = \frac{\text{opp}}{\text{adj}} = \frac{25}{x}
\]

\[
1.1732 = \frac{25}{x}
\]

\[
\therefore x = \frac{25}{1.1732} = 14.43\text{mm}
\]

\[
28 - 14.43 = 13.57\text{mm}
\]

- Part 1 to be finished to suit with part 2.
- Part 1 and 2 for straight and angular surfaces fit in a sliding way.
- Apply thin coat of oil to prevent corrosion and preserve it for evaluation.
Identify different ferrous metals by spark test

Objectives: At the end of this exercise you shall be able to
• support the metals on tool rest
• grind the metals on wheel face
• Identify different ferrous metals by spark test.

NOTE: INSTRUCTOR SHALL ARRANGE DIFFERENT FERROUS METALS FOR SPARK TEST
Job Sequence

- Prepare the grinding machine for grinding.
- Support the metals on tool rest/work rest.
- Apply light pressure on the face of wheel with metal.
- Grind the metals on wheel face.
- Identify the metal by spark length and colour.
- Grind the metal only on the face of the grinding wheel.

- Grind the following different metals and identify the sparks as shown in Fig 1 & 2

- Different metals
  - Low carbon steel.
  - Medium carbon steel.
  - High carbon steel.
  - High speed steel.
  - Stainless steel

Skill Sequence

Spark test

Objectives: This shall help you to
- identify the spark testing in different metals by grinding
- perform grinding process in grinding machines.

It is a method of determining the general classification of ferrous materials. It normally entails taking a piece of metal, usually scrap, and applying it to grinding wheel in order to observe the sparks emitted. These sparks can be compared to a chart or to sparks from a known test sample to determine the classification. Spark testing also can be used to sort ferrous materials, establishing the difference from one another by noting whether the spark is the same or different.

Spark testing is used because it is quick, easy and inexpensive. Moreover, test samples do not have to be prepared in any way, so, often, a piece of scrap is used. The main disadvantage to spark testing is its inability to identify a material positively; if positive identification is required, chemical analysis must be used. The spark comparison method also damages the material being tested, atleast slightly.

Spark testing most often is used in tool rooms, machine shops, heat treating shops, and foundries.
Process

A bench grinder is usually used to create the sparks, but sometimes this is not convenient, so a portable grinder is used. In either case, the grinding wheel must have adequate surface velocity, at least 23 m/s (4500 surface feet per minute (sfpm)), but should be between 38 and 58 m/s (7500 - 11500 sfpm). The wheel should be coarse and hard, therefore aluminium oxide or carborundum often are employed. The test area should be in an area where there is no bright light shining directly into the observer’s eyes. Moreover, the grinding wheel and surrounding area should be dark so that the sparks can be observed clearly. The test sample is then touched lightly to the grinding wheel to produce the sparks.

The important spark characteristics are colour, volume, nature of the spark, and length. Note that the length is dependent on the amount of pressure applied to the grinding wheel, so this can be a poor comparison tool if the pressure is not exactly the same for the samples. Also, the grinding wheel must be dressed frequently to remove metallic build-up.
Flaring of pipes and pipe joints

Objectives: At the end of this exercise you shall be able to
- cut a G.I pipe using a pipe cutter
- remove burrs using a pipe reamer
- flare the end pipe
- joint flare nut with flare fitting and test it.

Requirements

<table>
<thead>
<tr>
<th>Tools/Equipments</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Flaring block with yoke</td>
<td>• G.I pipe</td>
</tr>
<tr>
<td>• Adjustable wrench - 200 mm</td>
<td>• Flare nut to suit the pipe</td>
</tr>
<tr>
<td>• Valve key 6 mm (cylinder valve</td>
<td>• Thread seal tape</td>
</tr>
<tr>
<td>opener)</td>
<td>• Soap solution with strirrer</td>
</tr>
<tr>
<td>• Pressure gauge with adapter</td>
<td>• A small quantity of oil</td>
</tr>
<tr>
<td>• Flat file smooth - 200 mm</td>
<td></td>
</tr>
<tr>
<td>• Cylinder with pressure</td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of a flared pipe joint with dimensions and labels for flare, flare nut, pipe joint, and pipe.]

<table>
<thead>
<tr>
<th>1</th>
<th>Ø 12 x 200L</th>
<th>G I PIPE (Fe 310)</th>
<th>3.3.151</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO.OFF</td>
<td>STOCK SIZE</td>
<td>SEMI-PRODUCT</td>
<td>MATERIAL</td>
</tr>
</tbody>
</table>
Job sequence

- Check the material size and its conditions.
- File and check that end of the pipe must be exactly perpendicular to the pipe axis.
- Slightly deburr inside and outside edge of the pipe.
- Clean the pipe throughout before installing a flaring block.
- Insert and fix the pipe in to flaring block selected hole.

Examine the pipe flaring tool before starting to flare the end of a pipe.

- Place the yoke (flaring tool) to the flaring block.

Insert the flaring nut before flaring.

- Oil the cone and slowly screw it into the end of the pipe.
- The end of the pipe will be formed into a flare.

Do not over tighten the screws.

- Unscrew and remove the flared pipe from the block.
- Check the flare end for cracks.

Because the cone was screwed down too quickly flare is cracked.

- Make sure that the flare is in correct size. If any crack or too loose while fitting flare nut, cut off the flare and start again as per above instruction, until the flare is in correct size for the flare nut.

Skill sequence

Make flare joints and test them with flare fittings

Objectives: This shall help you to
- flare the end pipe
- join the flare nut with flare fitting and test it.

Flaring
Brake line pipes / fuel pipe lines / air conditioner pipe lines are sometimes jointed to fittings by making a flared connection.

The end of the pipe is opened out to form a cone (Fig 1).

Place the pipe in the tool (Fig 2). Make sure that you have:

a) Place the flare nut on the pipe
b) Chose the correct size hole in the flaring tool to fit the pipe; (there are 5 holes to fit different sizes of pipe.)

Always place the special flare nut on the pipe first before flaring.

Examine the pipe flaring tool. Make sure that you understand how it works before starting to flare the end of a pipe.

Make sure that the end of the pipe is free of rough edges before flaring.
If the pipe is ¼ inch (6 mm) in diameter, position the pipe so that the end is at least 2 mm above the top of the flaring block (Fig 3). (This distance is calculated as “pipe diameter divided by 3; in this case, 6 mm divided by 3 = 2 mm).

Tighten the nuts at each end of the flaring block (see drawing).

Fit the yoke to the flaring block (Fig 3).

Oil the cone and slowly screw it into the end of the pipe. The end of the pipe will be formed into a flare (Fig 4).

Unscrew & remove the flaring block. Remove the flared pipe from the block.

Examine the flare. If it has cracked, the cone was screwed down too quickly.

Make sure that the flare is in correct size. It should just fit inside the flare nut. If it is too loose, cut off the flare and start again as per instruction until the flare is correct size for the flare nut.

As per instruction, use 3 mm instead of 2 mm. Repeat until the flare is in correct size for the flare nut—not too loose and not too tight.

**Observation Table - 1**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Skills</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Checking Flaring</td>
<td>Cracked/uneven/too small/too long/correct</td>
</tr>
<tr>
<td>2</td>
<td>Number of attempts</td>
<td>One/two/three</td>
</tr>
</tbody>
</table>

Note: Repeat the steps to the various sizes of G.I.pipe

Joining with flare fittings

Put thread seal tape on the thread

Push back the flare nut and place the flared pipe on the fitting, then tighten the flare nut using adjustable wrench or suitable double end spanner.

Tighten the one end of the pipe to the cylinder with the flare nut. (Fig 5)

Connect a pressure gauge at the other end of the tube with flare nut.

**Do not give more pressure while tightening since this will spoil flare.**

**Make sure that they should not be loose in the pipe.**

---

**Capital Goods and Manufacturing : Fitter (NSQF Level-5) : Exercise : 3.3.151**
### Observation Table - 2

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Skills</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Selection of correct fittings</td>
<td>Correct/not correct</td>
</tr>
<tr>
<td>2</td>
<td>Joining method</td>
<td>Excellent/good/fair</td>
</tr>
<tr>
<td>3</td>
<td>Time taken</td>
<td>Less/very less/more</td>
</tr>
</tbody>
</table>

After joining the pipe firmly, open the cylinder valve with the help of valve key or ratchet.

The pressure will be shown in the pressure gauge.

Then close the cylinder valve. Major leaks will make noise and that needs the nut to be tightened.

If there is no leak, the pressure in the pressure gauge will remain constant.

If it decreases, check the joints with soap solution foam. Leak will bubble, then tighten the joints. If it stands still then there is no leak.

### Observation Table - 3

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Skills</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Selection of tools</td>
<td>Excellent/good/average</td>
</tr>
<tr>
<td>2</td>
<td>Detecting leak and arresting</td>
<td>Excellent/good/average</td>
</tr>
</tbody>
</table>

### Skill Sequence

#### Handling of pipe flaring & cutting tools

**Objective:** This shall help you to
- cut a G.I. pipe using a pipe cutter.

Measure the required length of pipe and mark it with chalk. Keep the pipe in the pipe vice and tighten it. (Fig 1)

Fit the pipe cutter on the G.I. pipe (on the scribed line) and tighten the jacking screw so that the cutting wheel is touching the pipe. (Fig 2)

Ensure that the pipe is kept horizontal and parallel to the serrations such that the marking is visible at the top.

Rotate one or two turns to ensure that the cutting wheel is sitting exactly on the scribed line at 90° to the pipe (Fig 3).

Rotate the pipe cutter around the pipe (Fig 4).

After two or three turns use the jacking screw to apply pressure on the cutting wheel (Fig 5).

Keep rotating the pipe cutter around the pipe. Increase the pressure to the cutter by repeating the cycle until the pipe is cut through (Fig 6).
Support the pipe with your left hand so that the free end of the pipe does not fall. (Fig 7)

The cut portion of the pipe will appear as shown in Fig 8.

Remove burrs using a pipe reamer. (Fig 9)

Check that the pipe ends are square. (Fig 10)
Inside edge of the pipe must be slightly deburred (Fig 11).

Outside edge of the pipe must be slightly deburred (Fig 12).

With this edge as reference the pipe is marked for bending (Fig 13).

Always use pipe bending fixture for proper bending of the pipe (Fig 14).

Clean the pipe thoroughly before installing in the machine. Prepare the pipe end for a flare fitting. Flaring with block and punch tool (Fig 15).

Pipe which is cleaned off burrs and bent should be selected. The pipe end is held in the flaring unit. Select the appropriate size of flaring unit to suit the pipe. Sleeve and cap nut should be assembled before flaring (Fig 16).

The flaring unit is held in a benchvice with the pipe (Fig 17).

Correct length of pipe should be projecting for flaring pipe edges should be in line with surface (Fig 18).
Using the flaring punch, flare the pipe end. Flaring can also be done by using a compression type flaring tool (Fig 19).

Installing a flare fitting

Flared tube is cleaned and the sleeve and cap nut are positioned on the flare. Check the flare angle is suitable to the sleeve angle (Fig 20).

Place the flare on the connector end. Confirm the angle is same (Fig 21).

Screw the cap nut on the connector thread by hand (Fig 22).

Use a suitable spanner and tighten the cap nut until the pipe does not rotate in the joint (Fig 23).
Cutting and threading of pipe length

Objectives: At the end of this exercise you shall be able to
- mark and cut pipe to length using pipe cutter
- mark and cut pipe to length using hacksaw.

Job sequence

- Hold the G.I pipe in pipe vice tightly.
- Mark the required length as per drawing.
- Fix the pipe in pipe vice and tighten it to prevent it from rotating.
- Fix the pipe cutter on the G.I pipe.
- Cut G.I pipe for the required length using pipe cutter.
- Remove burrs using pipe reamer.
- Check that the pipe ends with try square for squareness.
Skill sequence

Threading G.I. pipes using die stocks

Objective: This shall help you to
- cut threads on G.I. pipe using die stock.

Select a set of dies, and ratchet-type die stock (Fig 1 & 2).

Open the adjustment lever. (A)
Coincide the zero setting mark ‘0’ die stock and then insert the four dies according to the number on the dies and die stock respectively.
Ensure that the dies sit in the correct position.

Ensure that the projection of the pipe is within 150-250 mm from the vice.

Open the self-centering pipe guide and slide the stock over the end of the pipe.
Adjust the pipe guide for correct sliding, fit and lock into position (Fig 4)
Apply a cutting lubricant to the part which is to be threaded.

Use lard oil, or mineral-lard oil when threading G.I. pipes.

Apply a little pressure to the stock and keep the handle at right angle to the pipe axis.
When the dies bite into the pipe, stop pushing and continue the rotation by moving the handle up and down.
Apply the lubricant to the pipe after the first thread has been cut.
Keep rotating the handles clockwise and check the length of the pipe thread.

Ensure that the length of the thread is sufficient to fit halfway into the socket or coupling.
If the die stock and die stick, turn the stock anticlockwise to break the chips.
Reverse the ratchet knob, ease the handle and turn the stock anticlockwise till the stock and dies come out of the pipe.
Clean the thread with a wire brush.
Form thread until the pipe extends about one or two threads beyond the end of the stock.
Remove the stock and dies by operating the quick-release lever and clean off the thread with a wire brush.
Check the formation of thread with a standard fitting.
Repeat the operation if the thread is too tight, by adjusting the dies.

Fix the pipe in a pipe vice and tighten to prevent it from rotating. (Fig 3)

Apply a little pressure to the stock and keep the handle at right angle to the pipe axis.
When the dies bite into the pipe, stop pushing and continue the rotation by moving the handle up and down.
Apply the lubricant to the pipe after the first thread has been cut.
Keep rotating the handles clockwise and check the length of the pipe thread.

Ensure that the length of the thread is sufficient to fit halfway into the socket or coupling.
If the die stock and die stick, turn the stock anticlockwise to break the chips.
Reverse the ratchet knob, ease the handle and turn the stock anticlockwise till the stock and dies come out of the pipe.
Clean the thread with a wire brush.
Form thread until the pipe extends about one or two threads beyond the end of the stock.
Remove the stock and dies by operating the quick-release lever and clean off the thread with a wire brush.
Check the formation of thread with a standard fitting.
Repeat the operation if the thread is too tight, by adjusting the dies.
Objective: At the end of this exercise you shall be able to
• fix the GI Pipes with fittings as per drawing.
Job sequence

- Calculate the length of pipe required based on drawing.
- Cut the pipes as per the calculated length using pipe cutter/ hacksaw.
- Cut thread at the end of all the pipes using die stock.
- Fit tee 1 to the pipe 1 using pipe wrench.
- Fit the pipe 2 to tee 1 using pipe wrench after adopting the procedure.
- Fit tee 2 to pipe 2 using pipe wrench after adopting the procedure.
- Fit pipe 3 to tee 2 using pipe wrench after adopting the procedure.
- Fit elbow to pipe 3 using pipe wrench after adopting the procedure.
- Fit pipe 4 to elbow using pipe wrench after adopting the procedure.
- Fit a socket to pipe 4 using pipe wrench after adopting the procedure.
- Fit bibcock to socket using pipe wrench after adopting the procedure.
- Fit pipe 5 to tee 2 using pipe wrench after adopting the procedure.
- Fit socket to pipe 5 using pipe wrench after adopting the procedure.
- Fit bend to socket using pipe wrench after adopting the procedure.
- Fit socket to bend using pipe wrench after adopting the procedure.
- Fit pipe 6 to socket using pipe wrench after adopting the procedure.
- Fit tee 3 to pipe 6 using pipe wrench after adopting the procedure.
- Fit pipe 7 and 8 to tee - 3 using pipe wrench after adopting the procedure.
- Fit socket to pipe 7 and 8 using pipe wrench after adopting the procedure.
- Fit bibcock to sockets using pipe wrench after adopting the procedure.
- Remove any excess hemp, string or sealing tape after completing the joints, using hacksaw blade or a blow lamp.
- Assemble pipe with standard fittings.

Skill Sequence

Objective: This shall help you to
- assemble pipe and pipe fittings.

Hold the pipe No. 2 in a pipe vice (Fig 1).

Wind the hemp packing/cotton thread material on the external threads of the pipe (Fig 2).

Apply sealing compound over the pipe threads (Fig 3).
Fit Tee-2 to pipe No. 2 and tighten it using a pipe wrench.

Wind the hemp packing to external threads of all the pipes and standard fittings and apply sealing compound over the threads before joining with the other one (Fig 4).

Fit pipe No. 3 with Tee-2 (Fig 5).

Fit Elbow-1 to Pipe No. 3 (Fig 6).

Fit Elbow-1 to Pipe No. 4 (Fig 6).

Fit a socket to Pipe No. 4 (Fig 7).

Fit bib cock to socket.

Fit Pipe No. 5 to Tee-2 (Fig 8).

Fit Pipe No. 5 to socket (Fig 9).
Fit socket to Elbow - 2 on both ends (Fig 10).
Fit socket to Pipe No - 6 (Fig 10)

Fit Tee - 3 to Pipe No - 6, 7, 8 (Fig 11).

Fit socket to Pipe No - 7 (Fig 12).

Fit socket to Pipe No - 8 (Fig 13)

Assembling Elbow with pipe (Fig 14).

Capital Goods and Manufacturing : Fitter (NSQF Level-5) : Exercise : 3.3.153
Capital Goods and Manufacturing  
Fitter - Pipes and pipe fittings  

Bending of pipes - cold and hot

Objective: At the end of this exercise you shall be able to
• bend G.I. pipe by cold method as per template on a pipe bending machine.

TASK - 1

\[
\begin{align*}
\text{ID 25} & \quad \text{STRETCHED BEND 176.78MM} \\
& \quad \text{R 112.5} \\
& \quad \text{150(L1)} \\
& \quad \text{R 100} \\
& \quad \text{100(L2)} \\
\end{align*}
\]

\[
\begin{align*}
r &= 100\text{mm} \\
\text{Radius of the bend} &= R \\
&= 100 + (0.5 \times 25) \\
&= 100 + 12.5 \\
&= 112.5\text{mm} \\
\end{align*}
\]

\[
\begin{align*}
\text{Stretch of the bend} &= l \\
&= \frac{90}{360} \times 2 \times \frac{22}{7} \times 112.5 \\
&= \left(\frac{11 \times 112.5}{7}\right) \\
&= 176.78\text{mm} \\
\end{align*}
\]

\[
\begin{align*}
\therefore L &= \text{(length of pipe)} = L_1 + L_2 + l \\
&= 150 + 100 + 176.78 \\
&= 426.78\text{ mm} \\
\end{align*}
\]
Job sequence

File the pipe ends and check up its squareness. (Fig. 1)

Check the inside dia. of the pipe by using steel rule. (Fig. 2)

Select the standard former to suit the size of the pipe. (Fig. 4)

Fix the bending machine in a benchvice and ensure it is tightened properly. Locate the tube stop bar at the required position. (Fig. 5)

Set the roller on the bending arm by adjusting the screw and lock nut. (Fig. 6)

Bend the pipe by pulling the bending arm towards your body. (Fig. 7)

The sleeve bends the pipe round the former as the bending arm is pulled. The back stop holds the tails end of the pipe in position. (Fig. 8)

Please change the reading from inside diameter from 10cm. Measure the length of the pipe as per drawing

\[ r = \text{radius of bend (i.e) 150mm} \]
\[ \theta = \text{angle of bend} \]
\[ l = \text{length of curved portion} \]

then

\[ l = \frac{\pi \times D \times \theta}{360} \]

\[ L = \text{Total length} \]
\[ = L_1 + l + L_2 \]

Mark off the beginning and the end of the bend from the centre line. (Fig. 3)
Check the bend for squareness use a set square as shown. (Fig. 9)

Check level of former and first leg (90° bend) with spirit level by placing spirit levels as shown in Fig. 10.

Check the angle of bend and radius using standard template. (Fig. 11)

Bending 120° by Hydraulic bending machine

Fit the pipe former on to the cylinder arm. (Fig. 12)

Place the pipe between the forming head plates and against the former. (Fig. 13)

Support the pipe and fit dollies (or rollers) between the upper and lower plates of the forming head. Locate them in position by inserting pins through the plates and the dollies. (Fig. 14)

Close the pressure release valve on the pump body then start pumping to push the former against the pipe. (Fig. 15)
Turn the pressure release valve anti-clockwise to release the pressure in the hydraulic cylinder. When the arm has moved back about 6 mm to 10 mm close the pressure release valve to hold the ram steady. (Fig. 16)

Check both bends 90° and 120° by placing pipe on the layout. (Fig. 17)
Pipe bending by hot method

Objective: At the end of this exercise you shall be able to
• bend G.I. pipe by heating and match with template.

Radius of the bend = \( R = 100 + (0.5 \times 25) \)
\[ = 100 + 12.5 \]
\[ = 112.5 \]

Stretch of the bend = \( l \)
\[ = \frac{90}{360} \times 2 \times \frac{22}{7} \times 112.5 \]
\[ = \frac{11 \times 112.5}{7} \]
\[ = 176.78 \text{mm} \]

L (length of pipe) = \( L_1 + L_2 + l \)
\[ = 150 + 100 + 176.78 \]
\[ = 426.78 \text{mm} \]
**Job Sequence**

**Bending G.I. pipes using sand and pegs**

**Objective:** This shall help you to
- bend G.I. pipe by hot method.

File the pipe ends square. (Fig 1)

Remove burrs.

Calculate the length of pipe. (Fig 2)

If \( D \) = diameter of bend  
\( \phi \) = angle of bend  
\( l \) = length of curved portion

then, \( l = \frac{\pi \times D \times \phi}{360} \)

If \( OA \) = inner radius of bend (R)  
\( AB \) = radius of pipe (r)  
\( OB \) = radius of bend (R+r)

then, \( l = (R+r) \times Q \times 0.01745 \).

Total length of pipe = \( L_1 + L_2 + l \).

Measure and mark off the:
- centre of the bend (Fig 3)
- beginning and end of the bend from the centre line.

Measure the inside diameter of the pipe and select two suitable wooden pegs for the pipe. (Fig 4)

Plug one end of the pipe with a wooden peg. (Fig 5)

Fill the pipe with clean, dry and fine sand [Compress the sand by tapping the pipe up and down with a soft hammer.] (Fig 6) and plug the end.

Ensure that the entire pipe is filled with sand.
Clamp one end of the pipe in a vice and protect the clamped portion of the pipe with lead or copper shims. (Fig 7)

Heat the area to be bent with oxy-acetylene torch evenly until it glows dull red. (Fig 8)

The bend area should not be overheated. Pull down the pipe gently in the direction of the bend. (Fig 9)

Take short pulls until the correct bend angle is reached. (Fig 10-1,2,3)

Check the bend radius with a template. (Fig 11)

Apply heat throughout the whole operation and overbend slightly and straighten out the final bend. (Fig 10-4,5)

Ensure that the pipe is cooled before removing the plug.

Remove one end of the plug.

Remove the sand by tapping the pipe gently with a hammer.
Calculate the length of material for bending

Objective: This shall help you to
• calculate the required length of pipe for bending.

While bending a rod, sheet or pipe, due to the tensile force in the outer part of the material at the bending point, the material is stretched. (Fig 1 and 2) Due to the force of pressure in the inner part of the material at the bending point, the material is compressed.

The layer in the middle of the material is not subjected to either tension or compression. This is called the neutral axis. (Fig 2)

For calculating the length of material for bending, the material length at the neutral axis is taken into account.

The length of the blank/rod/pipe is the stretched length before bending. The stretched length is determined along the neutral axis. For calculating the stretched/elongated length of a rod/sheet/pipe while bending (Fig 3), first add all straight portions together.

\[ x + y + z + y + x = 2x + 2y + z \]

Then add the bent space distances together. For calculating this:- take the radius of the bent up to the neutral axis and also take the angle of the bend into consideration. (Fig 4).

Radius of the bend up to neutral axis

\[ = \text{inner radius} + 0.5 \times \text{thickness of sheet} \text{ OR diameter of rod or pipe. Angle of the bend with respect to Figs 3 & 4 is } 90. \]

Length of the curved space

\[ = \frac{\text{Angle of curve} \times 2\pi R}{360} \]

where ‘R’ is the radius of the curve at the neutral axis.

Calculation of stretching length (Fig 5)
There are four bends all having a 90° angle.

R (Radius up to neutral axis) = 3 + 1.5 = 4.5 mm

Stretch length of one bend = \( \frac{90}{360} \times 2x \times \frac{22}{7} \times 4.5 \)

For all the four bends = \( 4 \times \frac{90}{360} \times 2x \times \frac{22}{7} \times 4.5 = 28.28 \text{mm} \)

Total stretched length = 266 + 28.28 = 294.28 or = 295 mm

In the above calculation the angle of the bend is taken as 90°. For calculating the curved length for any bending angles the following formula can be used (Fig 6).

\[
\text{Length of curve} = \frac{\text{angle of curve}}{360°} \times 2\pi R
\]

Where R is the radius of the curve at the neutral axis.

\[
\text{Length of curve} = \frac{30°}{360°} \times 2\pi \times \frac{80}{360°}
\]

= 41.88 mm

Total length of material of 10 mm

= 60 + 41.88 + 100 = 201.88 mm

Assignment

Calculate the total length of the material required for bending the round rod as given in the drawing below.

Answer -
Dismantling & assembling - globe valves, sluice valves, stop cocks, seat valves and non-return valve

Objectives: At the end of this exercise you shall be able to
• dismantle, service and assemble a globe valve
• dismantle, service and reassemble a sluice valve (gate valve)
• dismantle, service and assemble a stop cock
• dismantle, service and assemble a seat valve
• dismantle, service and assemble a non-return valve.
TASK 2
SLUICE VALVE

TASK 3
STOP COCK

STOP COCK

UNION
TASK 4
SEAT VALVE

- Gland Packing
- Spring-Loaded Stuffing Box System
- Normal Bonnet
- Connection Elements
- Flat Seal
- Contoured Plug with Stem
- Seat Ring
- Profile Ring
- Three-Flange Body with Flanged End

TASK 5
NON-RETURN VALVE

1. [Label]
2. [Label]
3. [Label]
4. [Label]
5. [Label]
6. [Label]
7. [Label]
Job sequence

TASK 1: Globe valve

Parts:
1. Hand wheel or key
2. Shaft of spindle
3. Packing nut/gland nut
4. Stuffing box with packing
5. Bonnet
6. Thread portion of the spindle
7. Metal value or metal disk holder with rubber washer
8. Inlet
9. Outlet
10. Valve seat
11. Globe shaped body

Job Sequence

- Shut off the water by closing the main value.
- Close the gate value and remove the wheel nut with a spanner.
- Remove the gland nut from the bonnet.
- Clean out the old packing in the stuffing box.
- Remove the bonnet with the spindle from the body and clean all the parts.
- Coil the asbestos rope, smear it with water pump grease and push it down with a screw driver.
- Assemble the spindle gate to the bonnet.
- Assemble the gland nut, hand wheel and tighten the hand wheel nut.
- Open the gate value and tighten the gland nut until the packing is compressed sufficiently to stop the water escaping from the gland nut.

Do not use the gate valve to regulate the flow. It should be either in fully opened or fully closed condition.

TASK 2: Sluice/gate value

Parts:
1. Hand wheel or key
2. Shaft/spindle
3. Packing nut/gland nut
4. Stuffing box with packing
5. Bonnet
6. Screw adjustment
7. Seat and disk gate
8. Flow of water

Job Sequence

- Shut off the water by closing the main value.
- Close the gate value and remove the wheel nut with a spanner.
- Remove the gland nut from the bonnet.
- Clean out the old packing in the stuffing box.
- Remove the bonnet with the spindle from the body and clean all the parts.
- Coil the asbestos rope, smear it with water pump grease and push it down with a screw driver.

TASK 3: Stop cock

Requirements

<table>
<thead>
<tr>
<th>Tools/Instruments</th>
<th>Equipement/Machines</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Spanner</td>
<td>• Pipe vice</td>
</tr>
<tr>
<td>• Screw driver</td>
<td>• Bench vice</td>
</tr>
<tr>
<td>• File</td>
<td>• Oil can</td>
</tr>
<tr>
<td>• Hacksaw</td>
<td></td>
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<tr>
<td>• Hammer</td>
<td></td>
</tr>
<tr>
<td>• Pipe wrench</td>
<td></td>
</tr>
<tr>
<td>• Die set</td>
<td></td>
</tr>
<tr>
<td>• Screw spanner</td>
<td></td>
</tr>
<tr>
<td>• Pliers</td>
<td></td>
</tr>
<tr>
<td>• Stop cock</td>
<td></td>
</tr>
<tr>
<td>• Union</td>
<td></td>
</tr>
<tr>
<td>• Thread seal material</td>
<td></td>
</tr>
</tbody>
</table>

Capital Goods and Manufacturing: Fitter (NSQF Level-5): Exercise: 3.3.155
Job sequence

- Clean the pipe joints free from rust and dirt.
- Loosen the union and separate the pipe joint.
- Loosen and remove the pipe nipple from stop cock.
- Loosen and remove the stop cock from the pipe joint.
- Dismantle the stop cock parts one by one systematically.
- Clean all the parts properly.
- Check the parts of thread, if worn out replace with correct one. If it is in good condition clean it properly and use it.
- Check the washer, whether it is damaged or in good condition. If damaged, change the washer.
- Reassemble the parts to ensure in good condition.
- While assembling the dismantled parts last one should fit first and vice versa sequence.
- If the stop cock is in damaged condition, change it with new stop cock.
- Fit the stop cock to one end in lengthy pipe in the dismantled place pipe joint properly.
- Fit the pipe nipple to other end of stop cock properly.
- Next fit the union with pipe nipple properly.
- Apply pressure and test the pipe joints and stop cock. Check for leakage, if any to ensure proper working.

- The arrow, embossed on stop cock is to be in the direction of flow of water
- Check the direction of arrow before fitting stop cock.
- Don't over tighten stop cock, and other pipe fittings.
- Use proper tools for dismantling and assembling pipe fittings.

**TASK 4 : Seat Valve**

<table>
<thead>
<tr>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>tools/instruments</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
| • spanner set  
| • pipe wrench  
| • adjustable spanner  
| • screw driver  
| • water pump pliers |
| **materials** |
|  
|  
| • gate valve  
| • asbestos rope  
| • rubber sheet  
| • leather sheet  
| • emery sheet  
| • oil  
| • grease |

Job sequence

1. Close the seat valve by turning the hand wheel clockwise.
2. Remove the nut with a spanner and lift the wheel.
3. Remove the gland nut from the bonnet by turning it in the anticlockwise direction.
4. Remove the stuffing gland.
5. Clean out the old packing in the stuffing box.
6. Cut a standard asbestos rope to make a new packing.
7. Assemble and spindle gate to the bonnet.
8. Assemble the hand wheel and tighten the hand wheel nut.
9. Open the seat valve and tighten the gland nut until the packing is compressed sufficiently to stop the water escaping from the gland nut.

**Removal of spindle set and gate part**

1. Hold the spanner at bonnet neck.
2. Loosen the bonnet two or three turn, again loosen the bonnet 2 or 3 turn.

**note**

- Don't over tighten the gland nut.
- Filling the gasket should not be too much.
- Clean the disk gate with emery sheet.
**TASK 5: Non return valve**

### Requirements

<table>
<thead>
<tr>
<th><strong>Tools/Instruments</strong></th>
<th><strong>Materials</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Spanner set</td>
<td>• Gate valve</td>
</tr>
<tr>
<td>• Pipe wrench</td>
<td>• Asbestos rope</td>
</tr>
<tr>
<td>• Adjustable spanner</td>
<td>• Rubber sheet</td>
</tr>
<tr>
<td>• Screw driver</td>
<td>• Leather sheet</td>
</tr>
<tr>
<td>• Water pump pliers</td>
<td>• Emery sheet</td>
</tr>
</tbody>
</table>

#### Parts of non-return valve

1. Cap
2. Stop plug
3. Hinge pin
4. Hinge

5. Disc hinge nut
6. Disc
7. Body

#### Materials

- Gate valve
- Asbestos rope
- Rubber sheet
- Leather sheet
- Emery sheet
- Oil
- Grease

#### Job sequence

- Shut off the water by closing the main valve.
- Remove the cap from the valve body. (Fig 1)

- Remove the hinge pin and take out the disc.
- Separate the disc from the hinge. (Fig 2)
- Clean the seating area and the other parts of the disc.
- Assemble the disc and hinge plate with the pin.
- Check the function of the hinge unit.

- Replace the sealing material and assemble the cap to the body. (Fig 3)
- Open the main gate valve and check for leakage.

#### Note

- Don’t over tighten the hinge pin.
- Clean the seating area thoroughly.
- Replace the seating material carefully.
TASK 1: Non-return valve

Skill sequence

Globe valve-servicing

Objective: This shall help you to
• repair a globe valve.

Shut off the water by closing the main gate valve. (Fig 1)

Drain the system and release the water pressure of the system.

Unscrew the bonnet and lift off the bonnet from the body.
Select the correct size cutter and assemble it to the reseating tool. (Fig 2)

Insert the reseating tool into the body of the stopcock. (Fig 3)

Hold the handle on the top of the tool steadily and turn the feed screw clockwise until the cutter just touches the bottom seat. (Figs 4 & 5)

Face the bottom seat with the cutter by rotating the handle by gripping the feed screw. (Fig 6)

Ensure a minimum amount of metal is removed by adjusting the feed screw.

Loosen the feed screw and the adopter and remove the reseating tool from the body. (Fig 7)
Inspect the valve seat using the beam of a flash light. (Fig 8)

Clean the seat and ensure that it is free from burrs, chips etc.

Replace the packing material into the gland box.
Tighten the bonnet. (Fig 9)

Avoid overtightening as this would cause damage to the thread of the body.

Close all the drain taps and open the main gate valve and check the globe valve for leakage.
TASK 2: Gate valve

Skill sequence

Repair a gate valve

Objective: This shall help you to
• repair a gate valve.

Close the gate-valve by turning the hand wheel clockwise. (Fig 1)

This will stop the water in the valve to be repaired.

Remove the nut with a spanner and lift off the wheel. (Fig 2)

Remove the gland nut from the bonnet by turning it in the anticlockwise direction. (Fig 3)

Remove the stuffing gland. (Fig 4)

Clean out the old packing in the stuffing box. (Fig 5)
Cut a strand of asbestos rope to make a new packing. (Smear it with water pump grease or graphite paste) (Fig 6)

Coil the new packing round the shaft and push it down with a screw driver. (Fig 7)

Push in the stuffing gland and check that it fits tightly in the stuffing box. (Fig 8)

Reassemble and leave the gland nut hand tight. (Fig 9)

Assemble the hand wheel and tighten the hand wheel nut. (Fig 10)

Open the gate valve and tighten the gland nut until the packing is compressed sufficiently to stop the water escaping from the gland nut. (Fig 11)
Fit & assemble pipes, valves and test for leakage & functionality of valves

Objectives: At the end of this exercise you shall be able to
- fit the elbow with G.I. pipe
- fit the union with G.I. pipe
- fit valves with G.I. pipe
- assemble pipe with standard fittings.

TASK - 1
TASK 1: Assembling of pipes and valves

Job sequence

- Join pipe No. 2 with the 4-way cross. (B)
- Fit pipe No. 3 with the ‘cross’.
- Join plain coupling (G) to the other end of the pipe No. 3.
- Assemble G.I. bend (H) to the plain coupling.
- Fit the ribbed coupling (I) to the other end of the bend.
- Join pipe No. 4 to the ribbed coupling.
- Fit ‘T’ (J) with pipe No. 4.
- Join pipe No. 5 to the opposite end of ‘T’.
- Assemble elbow (M) with pipe No. 5.
- Fit pipe No. 6 with the other end of the elbow.
- Join ‘T’ with pipe No. 6.
- Fit pipe No. 1 with the opposite end of ‘T’.
- Join pipe Nos. 1 & 2 with union. (A)
- Fit 150mm barrel nipple (P) to the left side of the ‘cross’ and put cap (A) for it.
- Put another 100mm barrel nipple (C) to the right side of the cross.
- Join the reducer (E) to the barrel nipple.
- Assemble the bib-cock (F) to the other end of the reducer.
- Fit 100mm barrel nipple (K) to bottom ‘T’.
- Assemble the globe valve (L) to the nipple.
- Put the hexagonal nipple (O) to the left side ‘T’.
- Assemble the gate-valve to the nipple.
- Test the joints for leakage.

<table>
<thead>
<tr>
<th>No.</th>
<th>Stock Size</th>
<th>Description</th>
<th>Material</th>
<th>DRG. NO. (ASSY)</th>
<th>PART NO.</th>
<th>EX. NO.</th>
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<td>L</td>
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<td>K</td>
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<td>2</td>
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<td>1/2 INCH</td>
<td>BIB COCK</td>
<td>BRASS</td>
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<td>CAP</td>
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<tr>
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<td>BARREL NIPPLE</td>
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<td>UNION (WITH WASHER)</td>
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ASSEMBLY OF G.I. PIPES, VALVES AND STANDARD PIPE FITTINGS

CODE NO. FIN3156E2
TASK 2 : Test for leakage and functionality of valves

Job sequence

- Prepare the pressure testing machine.
- Fill up water in pressure testing machine.
- Connect the pressure testing machine tube with pipe fittings assembly to be tested.
- Before connecting hose pipe with pipe fittings, plug all the openings in the section of test line with pipe nipples socket and plug.
- Apply the pressure to test the pipe line completely without any air.
- Pump the water into the pipeline.
- Trace the pipe lines to find leakages.
- Tight the pipe fittings properly, if leakage is there.
- Apply pressure again and again test the pipe fittings assembly for proper functioning.
- Remove hose pipe from pressure testing machine if leakages are not there.
- Connect the pipe fittings with the existing pipe line.

While fixing the pipe fittings with pipe lines use proper materials to avoid leakages.
- Don't over tighten the pipe fittings while fitting with pipes.
TASK 1:

Skill Sequence

Assemble GI pipes with standard fittings

Objective: This shall help you to
- assemble pipe and pipe fittings.

1. Hold the pipe No.2 in a pipe vice. (Fig 1)

2. Wind the hemp packing/cotton thread material on the external threads of the pipe. (Fig 2)

3. Apply sealing compound over the pipe threads. (Fig 3)

4. Fit the 4-way cross to pipe No.2 and tighten it using a pipe wrench.

5. Fit pipe No.3 with the cross. (Fig 5)

6. Join the plain coupling to the other end of the pipe No.3. (Fig 6)

7. Fit the G.I. bend to the plain coupling. (Fig 7)

Wind the hemp packing to external threads of all the pipes and standard fittings and apply sealing compound over the threads before joining with the other one (Fig 4).
8. Assemble the ribbed coupling to the other end of the G.I. bend. (Fig 8)

9. Connect pipe No.4 to the ribbed coupling. (Fig 9)

10. Fit 'T' with pipe No.4. (Fig 10)

11. Connect pipe No.5 to the opposite end of 'T'. (Fig 11)

12. Assemble the elbow with pipe No.5. (Fig 12)

13. Fit pipe No.6 with the other end of the elbow. (Fig 13)

14. Connect 'T' with pipe No.6. (Fig 14)
15 Fit pipe No.1 with the opposite end of 'T'. (Fig 15)

16 Fit the rubber washer into the union.

17 Set pipe Nos. 1 & 2 with the union.

18 Hold one side of the union in one pipe wrench and the ring of the union in the other. (Fig 16)

19 Turn the two pipe wrenches gently in opposite directions and assemble.

Use grease or vaseline on the union joint for easy dis-connection.

20 Fit a 150 mm barrel nipple to the left side of the cross and put a cap for it. (Fig 17)

21 Join another 150 mm barrel nipple to the right side of the cross. (Fig 18)

22 Connect the reducer to the barrel nipple. (Fig 19)

23 Assemble a bib-cock to the other end of the reducer. (Fig 20)
24 Fit a 100 mm barrel nipple to the bottom side of ‘T’. (Fig 21)

25 Assemble the gate-valve to the 100 mm barrel nipple. (Fig 22)

26 Allow a clearance between the valve and pipe. (Fig 22)

27 Join a hexagonal nipple to the left side ‘T’.

28 Assemble a globe valve to the hexagonal nipple.

29 Check the joint for leakage.

Do not overtighten the fittings as this may cause the threads to the split.
Visual inspection for visual defects e.g. dents, surface finish

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

- visual identification of defects on various metal sections.
Job sequence

Instructor shall explain various defects on metal surfaces and demonstrate the same with the available surface finish damaged raw material, dent pipes and sheet metal etc.

• Ask the trainees to identify the visuals and record it in table.

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Visuals</th>
<th>Nature of defect</th>
</tr>
</thead>
<tbody>
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<td>10</td>
<td><img src="image10.png" alt="Visual 10" /></td>
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</tr>
</tbody>
</table>

- Get it checked by your Instructor.
Objective: At the end of this exercise you shall be able to
- measure the dimensions and prepare the chart.

Instructor has to prepare 20 components as per drawing and keep it ready.

Ask the 20 trainees to check and measure all the 20 components hole size and plot the same reading on the control chart.

NOTE:

20 H:\ = 20
Instructor shall ask the trainees to measure each component hole size and record it on the chart.

Get it checked by your Instructor.
### Enter each trainee's component hole diameter

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Trainee token No.</th>
<th>Reading in mm</th>
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</thead>
<tbody>
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