FITTER
NSQF Level - 5

1st Year (Volume I of II)

TRADE PRACTICAL

SECTOR: Capital Goods & Manufacturing
Sector: Capital Goods & Manufacturing
Duration: 2 - Years
Trade: Fitter 1st Year (Volume I of II) - Trade Practical - NSQF (Level - 5)

Developed & Published by

National Instructional Media Institute
Post Box No.3142
Guindy, Chennai - 32
INDIA
Email: Chennai-nimi@nic.in
Website: www.nimi.gov.in

Copyright © 2018 National Instructional Media Institute, Chennai
First Edition: August 2018 Copies: 1,000

Rs.275/-
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 1st Year (Volume I of II) - Trade Practical NSQF Level - 5 in Capital Goods & Manufacturing Sector under Semester 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

RAJESH AGGARWAL
Director General/ Addl. Secretary
Ministry of Skill Development & Entrepreneurship,
Government of India.

New Delhi - 110 001
PREFACE

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 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
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 & Manufacturing Sector for ITIs.

MEDIA DEVELOPMENT COMMITTEE MEMBERS

Shri. A. Vijayaraghavan - Assistant Director of Training (Retd.), ATI, Chennai - 32
Shri. K. Lakshminarayanan - Training Officer (Retd.), DET, Tamilnadu
Shri. G. Mani - Junior works Manager (Retd) Ordinance Factory Board
Shri. K. Kesavan - Asst. App. Advisor Junior (Retd) DET, Tamilnadu
Shri. C. C. Subramanian - Training Officer (Retd.) Balamandir PHM ITI, Chennai - 17
Shri. G. Sangareeswari - JTO Govt ITI Guindy, Chennai - 32
Shri. J.P. Pandy - Training Officer Govt ITI, Madhya pradesh

NIMI CO-ORDINATORS

Shri. K. Srinivasa Rao - Joint Director, NIMI, Chennai - 32
Shri. V. Gopalakrishnan - Assistant Manager, NIMI, Chennai - 32

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 volume I of II course of 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 four modules. The distribution of time for the practical in the four modules are given below:

<table>
<thead>
<tr>
<th>Module</th>
<th>Subject</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module 1</td>
<td>Safety</td>
<td>25 Hrs</td>
</tr>
<tr>
<td>Module 2</td>
<td>Basic Fitting</td>
<td>275 Hrs</td>
</tr>
<tr>
<td>Module 3</td>
<td>Sheet Metal</td>
<td>150 Hrs</td>
</tr>
<tr>
<td>Module 4</td>
<td>Welding</td>
<td>100 Hrs</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>550 Hrs</td>
</tr>
</tbody>
</table>

The skill training in the shop floor is planned through a series of practical exercise centered 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 trainees. 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 first 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 indication about the corresponding practical exercises are given in every sheet of this manual.

It will be preferable to teach/learn trade theory connected to each exercise at least one class before performing the related skill 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>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1.01</td>
<td>Importance of trade training, list of tools and machinery used in the trade</td>
<td>1</td>
</tr>
<tr>
<td>1.1.02</td>
<td>Safety attitude development of the trainee by educating them to use personal</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>protective equipment (PPE)</td>
<td></td>
</tr>
<tr>
<td>1.1.03</td>
<td>First aid method and basic training (QR Code Page No. 10)*</td>
<td>6</td>
</tr>
<tr>
<td>1.1.04</td>
<td>Safe disposal of waste materials like cotton waste, metal chips/burrs etc.</td>
<td>11</td>
</tr>
<tr>
<td>1.1.05</td>
<td>Hazard identification and avoidance</td>
<td>12</td>
</tr>
<tr>
<td>1.1.06</td>
<td>Safety signs for danger, warning, caution and personal safety message</td>
<td>15</td>
</tr>
<tr>
<td>1.1.07</td>
<td>Preventive measures for electrical accidents and step to be taken in such accidents</td>
<td>17</td>
</tr>
<tr>
<td>1.1.08</td>
<td>Uses of fire extinguishers</td>
<td>19</td>
</tr>
<tr>
<td>1.1.09</td>
<td>Practice and understand precautions to be followed while working in fitting jobs</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>(QR Code Page No. 24)*</td>
<td></td>
</tr>
<tr>
<td>1.1.10</td>
<td>Safe use of tools and equipments used in the trade (QR Code Page No. 26)*</td>
<td>25</td>
</tr>
<tr>
<td>1.2.11</td>
<td>Identification of tools &amp; equipments as per desired specifications for marking &amp;</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>sawing</td>
<td></td>
</tr>
<tr>
<td>1.2.12</td>
<td>Selection of material as per application</td>
<td>30</td>
</tr>
<tr>
<td>1.2.13</td>
<td>Visual inspection of raw material for rusting, scaling, corrosion etc</td>
<td>32</td>
</tr>
<tr>
<td>1.2.14</td>
<td>Marking out lines, gripping suitably in vice jaws, hacksawing to given dimensions</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>(QR Code Page No. 39)*</td>
<td></td>
</tr>
<tr>
<td>1.2.15</td>
<td>Sawing different types of metals of different sections (QR Code Page No. 43)*</td>
<td>40</td>
</tr>
<tr>
<td>1.2.16</td>
<td>Filing Channel, Parallel</td>
<td>44</td>
</tr>
<tr>
<td>1.2.17</td>
<td>Filing - Flat and square (rough finish) (QR Code Page No. 50)*</td>
<td>49</td>
</tr>
<tr>
<td>1.2.18</td>
<td>Filing practice, surface filing, marking of straight and parallel lines with odd leg</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>calipers and steel rule.</td>
<td></td>
</tr>
<tr>
<td>1.2.19</td>
<td>Marking practice with dividers, odd leg calipers and steel rule (circles, arcs,</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>parallel lines)</td>
<td></td>
</tr>
<tr>
<td>1.2.20</td>
<td>Marking off straight lines and arc's using scribing block and dividers</td>
<td>56</td>
</tr>
</tbody>
</table>

---

**Module 1: Safety**

- Importance of trade training, list of tools and machinery used in the trade
- Safety attitude development of the trainee by educating them to use personal protective equipment (PPE)
- First aid method and basic training (QR Code Page No. 10)*
- Safe disposal of waste materials like cotton waste, metal chips/burrs etc.
- Hazard identification and avoidance
- Safety signs for danger, warning, caution and personal safety message
- Preventive measures for electrical accidents and step to be taken in such accidents
- Uses of fire extinguishers
- Practice and understand precautions to be followed while working in fitting jobs (QR Code Page No. 24)*
- Safe use of tools and equipments used in the trade (QR Code Page No. 26)*

**Module 2: Basic Fitting**

- Identification of tools & equipments as per desired specifications for marking & sawing
- Selection of material as per application
- Visual inspection of raw material for rusting, scaling, corrosion etc
- Marking out lines, gripping suitably in vice jaws, hacksawing to given dimensions (QR Code Page No. 39)*
- Sawing different types of metals of different sections (QR Code Page No. 43)*
- Filing Channel, Parallel
- Filing - Flat and square (rough finish) (QR Code Page No. 50)*
- Filing practice, surface filing, marking of straight and parallel lines with odd leg calipers and steel rule.
- Marking practice with dividers, odd leg calipers and steel rule (circles, arcs, parallel lines)
- Marking off straight lines and arc's using scribing block and dividers
<table>
<thead>
<tr>
<th>Exercise No.</th>
<th>Title of the Exercise</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2.21</td>
<td>Chipping flat surfaces along a marked line (QR Code Page No. 60)*</td>
<td>59</td>
</tr>
<tr>
<td>1.2.22</td>
<td>Marking, filing, flat square and check using tri-square</td>
<td>61</td>
</tr>
<tr>
<td>1.2.23</td>
<td>Marking according to simple blue prints for locating position of holes, scribing lines on chalked surfaces with marking tools</td>
<td>62</td>
</tr>
<tr>
<td>1.2.24</td>
<td>Finding centre of round bar with the help of ‘V’ block and marking block</td>
<td>65</td>
</tr>
<tr>
<td>1.2.25</td>
<td>Joining straight line to an arc</td>
<td>67</td>
</tr>
<tr>
<td>1.2.26</td>
<td>Chipping, chamfering, chip slots and oil grooves (straight)</td>
<td>73</td>
</tr>
<tr>
<td>1.2.27</td>
<td>Filing flat, square and parallel to an accuracy of ± 0.5mm</td>
<td>75</td>
</tr>
<tr>
<td>1.2.28</td>
<td>Chip curve along a line-mark out, key ways at various angles and cut keyways</td>
<td>77</td>
</tr>
<tr>
<td>1.2.29</td>
<td>Sharpening of chisel</td>
<td>80</td>
</tr>
<tr>
<td>1.2.30</td>
<td>File thin metal to an accuracy of 0.5 mm</td>
<td>83</td>
</tr>
<tr>
<td>1.2.31</td>
<td>Saw along a straight line, curved line, on different sections of metals</td>
<td>85</td>
</tr>
<tr>
<td>1.2.32</td>
<td>Straight saw on thick section of M.S. angle and pipe</td>
<td>89</td>
</tr>
<tr>
<td>1.2.33</td>
<td>File steps and finish with smooth file to accuracy of ± 0.25 mm.</td>
<td>91</td>
</tr>
<tr>
<td>1.2.34</td>
<td>File and saw on M.S. square and pipe</td>
<td>93</td>
</tr>
<tr>
<td>1.2.35</td>
<td>File radius along a marked line (convex and concave) and match</td>
<td>95</td>
</tr>
<tr>
<td>1.2.36</td>
<td>Chip sheet metal (shearing)</td>
<td>98</td>
</tr>
<tr>
<td>1.2.37</td>
<td>Chip step and file</td>
<td>101</td>
</tr>
<tr>
<td>1.2.38</td>
<td>Mark off and drill through holes</td>
<td>102</td>
</tr>
<tr>
<td>1.2.39</td>
<td>Drill and tap on M.S. flat</td>
<td>105</td>
</tr>
<tr>
<td>1.2.40</td>
<td>Punch letter and number (letter punch and number punch)</td>
<td>109</td>
</tr>
<tr>
<td>1.2.41</td>
<td>Practice use of different punches</td>
<td>111</td>
</tr>
<tr>
<td><strong>Module 3 : Sheet Metal</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3.42</td>
<td>Marking of straight lines, circles, profiles and various geometrical shapes and cutting the sheets with snips</td>
<td>113</td>
</tr>
<tr>
<td>1.3.43</td>
<td>Marking out of simple development (QR Code Page No. 132)*</td>
<td>128</td>
</tr>
<tr>
<td>1.3.44</td>
<td>Marking out for flaps for soldering and sweating</td>
<td>133</td>
</tr>
<tr>
<td>Exercise No.</td>
<td>Title of the Exercise</td>
<td>Page No.</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>1.3.45</td>
<td>Make various joints: wiring, hemming, soldering and brazing, form locked,</td>
<td>140</td>
</tr>
<tr>
<td></td>
<td>grooved and knocked up single hem straight and curved edges form double hemming</td>
<td></td>
</tr>
<tr>
<td>1.3.46</td>
<td>Punch holes-using hollow and solid punches</td>
<td>158</td>
</tr>
<tr>
<td>1.3.47</td>
<td>Do lap and butt joints</td>
<td>163</td>
</tr>
<tr>
<td>1.3.48</td>
<td>Bend sheet metal into various curvature form, funnel</td>
<td>166</td>
</tr>
<tr>
<td>1.3.49</td>
<td>Make simple square container with wired edge and fix handle</td>
<td>183</td>
</tr>
<tr>
<td>1.3.50</td>
<td>Make square tray with square soldered corner</td>
<td>191</td>
</tr>
<tr>
<td>1.3.51</td>
<td>Practice on soft soldering and silver soldering</td>
<td>194</td>
</tr>
<tr>
<td>1.3.52</td>
<td>Make riveted lap and butt joint</td>
<td>199</td>
</tr>
<tr>
<td>1.3.53</td>
<td>Make funnel as per development and solder joints</td>
<td>205</td>
</tr>
<tr>
<td>1.3.54</td>
<td>Drill for riveting</td>
<td>207</td>
</tr>
<tr>
<td>1.3.55</td>
<td>Riveting with as many types of rivet as available, use of counter sunk head rivets</td>
<td>209</td>
</tr>
<tr>
<td></td>
<td><strong>Module 4 : Welding</strong></td>
<td></td>
</tr>
<tr>
<td>1.4.56</td>
<td>Striking and maintaining arc, laying straight - line bead</td>
<td>215</td>
</tr>
<tr>
<td>1.4.57</td>
<td>Making square, Butt joint and 'T' fillet joint - gas and arc</td>
<td>221</td>
</tr>
<tr>
<td>1.4.58</td>
<td>Setting up of flames, fusion runs with and without filler rod and gas</td>
<td>237</td>
</tr>
<tr>
<td>1.4.59</td>
<td>Butt weld and corner, fillet in arc welding</td>
<td>245</td>
</tr>
<tr>
<td>1.4.60</td>
<td>Gas cutting of MS plates (QR Code Page No. 260)*</td>
<td>253</td>
</tr>
</tbody>
</table>

*Steps to download and scan the Quick Response (QR) code
- Download QR code app on your phone
- Run app and scan the QR code
- Your smartphone will read the code and navigate to the destination
On completion of this book you shall be able to

- Recognise & Comply Safe working Practices, environment regulation and house keeping

- Plan and Organize the work to make job as per specification applying different types of basic fitting operation and check for dimensional accuracy. (Basic fitting operation - marking, hacksawing, chiseling, filing, drilling, taping and grinding etc., Accuracy ± 0.25mm)

- Manufacture Simple Sheet Metal items as per drawing and join them by soldering, brazing and riveting.

- Join Metal Components by arc welding observing standard procedure.

- Cut and Join Metal Component by gas (Oxy-acetylene)

- Cut and Join Metal Component by gas (Oxy-acetylene) & Join Metal components by riveting observing standard procedure.
Importance of trade training, list of tools & machinery used in the trade

Objectives: At the end of this exercise you shall be able to
• identify the tools and equipments used in fitter section
• record the names of tools, do’s and don’t of each tool
• record the names of the industries where the fitters are employed.
Instructor shall brief the role of a fitter in industries. Emphasis more on the assembly shop by providing the names of the private and public sector industries, where the fitters are largely employed. Ask the trainees to note down the names of the industries.

Job Sequence

Instructor shall display all the tools and equipments in the section and brief their names, uses and the safety point to be observed for each tool and equipment.

- Trainees will note down all the displayed tools names, uses and the precaution to be observed while working with each tool.
- Record it in Table 1.
- Get it checked by the instructor.

Table 1

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Name of tool/equipment</th>
<th>Uses</th>
<th>Precaution to be observed (Do’s and Don’t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Instructor shall brief the role of a fitter in industries. Emphasis more on the assembly shop by providing the names of the private and public sector industries, where the fitters are largely employed. Ask the trainees to note down the names of the industries.
Safety attitude development of the trainee by educating them to use personal protective equipment (PPE)

Objectives: At the end of this exercise, you shall be able to
- identify personal protective devices
- interpret the different types of personal protective devices
- identify occupational hazards and the corresponding potential hazards.

<table>
<thead>
<tr>
<th>Fig 1</th>
<th>Fig 2</th>
<th>Fig 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fig 4</td>
<td>Fig 5</td>
<td>Fig 6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fig 7</td>
<td>Fig 8</td>
<td>Fig 9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<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>
<th>1.1.02</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**IDENTIFY THE CATEGORIES OF PERSONAL PROTECTIVE DEVICE**

CODE NO. FIN1102E1
Job Sequence

- Read and interpret the visuals of personal protective equipment on real devices or from the charts.
- Identify and select personal protective equipment used for different types of protection.
- Write the name of the PPE and the corresponding type of protection and the hazards in table 1.

The instructor shall display the different types of personal protective equipments or charts and explain how to identify and select the PPE devices suitable for the work and ask the trainees to note down the hazards and type of protection in the Table 1.

---

**TASK 1:**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of the PPE</th>
<th>Hazards</th>
<th>Type of protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Get it checked by your instructor.

---

**TASK 2:**

Instructor may brief the various types of occupational hazards and their causes.

- Identify the occupational hazard and the corresponding situation with the potential harm and record it in Table 2.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Source or potential harm</th>
<th>Type of occupational hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Noise</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Explosive</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Virus</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Sickness</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Smoking</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Non control device</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>No earthing</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Poor house keeping</td>
<td></td>
</tr>
</tbody>
</table>

Fill up and get it checked by your instructor.
First aid method and basic training

Objectives: At the end of this exercise, you shall be able to
• rescue breathing for an unconscious victim of different condition
• perform treatment for stopping of bleeding.

Job Sequence

Assumption - For easy manageability, Instructor may arrange the trainees in group and ask each group to perform one method of resuscitation.

TASK1: Prepare the victim to receive artificial respiration

1. Loosen the tight clothing which may interfere with the victim’s breathing.
2. Remove any foreign materials or false teeth from his mouth and keep the victim’s mouth open.
3. Bring the victim safely to the level ground, taking necessary safety measures.
4. Start artificial respiration immediately without delay. Do not waste too much time in loosening the clothes or trying to open the tightly closed mouth.
5. Avoid violent operations to prevent injury to the internal parts of the victim.
6. Send word for a doctor immediately.

TASK 2: Resuscitate the victim by Nelson’s arm - Lift back pressure method

Nelson’s arm-lift back pressure method must not be used in case there are injuries to the chest and belly.

1. Place the victim prone (that is face down) with his arms folded with the palms one over the other and the head resting on his cheek over the palms. Kneel on one or both knees near the victim’s hand. Place your hands on the victim’s back beyond the line of the armpits, with your fingers spread outwards and downwards, thumbs just touching each other as in Fig 1.

Fig 1
2 Gently rock forward keeping your arms straight until they are nearly vertical, and steadily pressing the victim’s back as shown in Fig 2 to force the air out of the victim’s lungs.

3 Synchronise the above movement of rocking backwards with your hands sliding downwards along the victim’s arms, and grasp his upper arm just above the elbows as shown in Fig 3. Continue to rock backwards.

4 As you rock back, gently raise and pull the victim’s arms towards you as shown in Fig 4 until you feel tension in his shoulders. To complete the cycle, lower the victim’s arms and move your hands up to the initial position.

5 Continue artificial respiration till the victim begins to breathe naturally. Please note, in some cases, it may take hours.

6 When the victim revives, keep the victim warm with a blanket, wrapped up with hot water bottles or warm bricks; stimulate circulation by stroking the insides of the arms and legs towards the heart.

7 Keep him in the lying down position and do not let him exert himself.

**Do not give him any stimulant until he is fully conscious.**

**TASK 3: Resuscitate the victim by Schafer’s method**

**Do not use this method in case of injuries to victim on the chest and belly.**

1 Lay the victim on his belly, one arm extended direct forward, the other arm bent at the elbow and with the face turned sideward and resting on the hand or forearm as shown in Fig 5.

2 Kneel astride the victim, so that his thighs are between your knees and with your fingers and thumbs positioned as in Fig 5.

3 With the arms held straight, swing forward slowly so that the weight of your body is gradually brought to bear upon the lower ribs of the victim to force the air out of the victim’s lungs as shown in Fig 6.
4 Now swing backward immediately removing all the pressure from the victim's body as shown in Fig 7, thereby, allowing the lungs to fill with air.

5 After two seconds, swing forward again and repeat the cycle twelve to fifteen times a minute.

6 Continue artificial respiration till the victim begins to breathe naturally.

---

**TASK 4: Resuscitate the victim by mouth-to-mouth method**

1 Lay the victim flat on his back and place a roll of clothing under his shoulders to ensure that his head is thrown well back. (Fig 8)

2 Tilt the victim’s head back so that the chin points straight upward. (Fig 9)

3 Grasp the victim’s jaw as shown in Fig 10, and raise it upward until the lower teeth are higher than the upper teeth; or place fingers on both sides of the jaw near the ear lobes and pull upward. Maintain the jaw position throughout the artificial respiration to prevent the tongue from blocking the air passage.

4 Take a deep breath and place your mouth over the victim’s mouth as shown in Fig 11 making airtight contact. Pinch the victim’s nose shut with the thumb and forefinger. If you dislike direct contact, place a porous cloth between your mouth and the victim’s. For an infant, place your mouth over his mouth and nose.

---
5 Blow into the victim’s mouth (gently in the case of an infant) until his chest rises. Remove your mouth and release the hold on the nose, to let him exhale, turning your head to hear the rushing out of air. The first 8 to 10 breathings should be as rapid as the victim responds, thereafter the rate should be slowed to about 12 times a minute (20 times for an infant).

If air cannot be blown in, check the position of the victim’s head and jaw and recheck the mouth for obstructions, then try again more forcefully. If the chest still does not rise, turn the victim’s face down and strike his back sharply to dislodge obstructions.

Sometimes air enters the victim’s stomach as evidenced by a swelling stomach. Expel the air by gently pressing the stomach during the exhalation period.

---

**TASK 5: Resuscitate the victim by Mouth-to-Nose method**

*Use this method when the victim’s mouth will not open, or has a blockage you cannot clear.*

1 Use the fingers of one hand to keep the victim’s lips firmly shut, seal your lips around the victim’s nostrils and breathe into him. Check to see if the victim's chest is rising and falling. (Fig 12)

2 Repeat this exercise at the rate of 10 - 15 times per minute till the victim responds.

3 Continue this exercise till the arrival of the doctor.

---

**TASK 6: Resuscitate a victim who is under cardiac arrest by (CPR) cardio pulmonary resuscitation**

*In cases where the heart has stopped beating, you must act immediately.*

1 Check quickly whether the victim is under cardiac arrest.

Cardiac arrest could be ascertained by the absence of the cardiac pulse in the neck (Fig 13), blue colour around lips and widely dilated pupil of the eyes.

2 Lay the victim on his back on a firm surface.

3 Kneel alongside facing the chest and locate the lower part of the breastbone. (Fig 14)

4 Place the palm of one hand on the centre of the lower part of the breastbone, keeping your fingers off the ribs. Cover the palm with your other hand and lock your fingers together as shown in Fig 15.

---

Capital Goods & Manufacturing : Fitter - Exercise 1.1.03
5  Keeping your arms straight, press sharply down on the lower part of the breastbone; then release the pressure. (Fig 16)
6  Repeat step 5, fifteen times at the rate of at least once per second.

7 Check the cardiac pulse. (Fig 17)

8 Move back to the victim’s mouth to give two breaths (mouth-to-mouth resuscitation). (Fig 18)

9 Continue with another 15 compressions of the heart followed by a further two breaths of mouth-to-mouth resuscitation, and so on, check the pulse at frequent intervals.

**TASK 7: Treatment for bleeding victim**

1 Determine the location of the bleeding.
2 Elevate the injured area above the heart if possible.
3 Apply direct pressure to the bleeding area with sterile cloth.
4 Keep the pressure on for 5 seconds.
5 Check to see if the bleeding has stopped if not apply further pressure for 15 minutes.
6 Clean the wound.
7 Bandage the wound with pad of soft material. (Fig 20)
8 Advice victim to take treatment from doctor.

---

Scan the QR code to view the video for this exercise
Safe disposal of waste materials like cotton waste, metal chips / burrs etc.

Objectives: At the end of this exercise you shall be able to
- identify and segregate the waste material in workshop
- arrange the waste material in different bins.

Job Sequence

- Separate the cotton waste.
- Collect the chips by hand shovel with the help of brush. (Fig.2).
- Clean the floor, if oil is spilled.
- Separate the cotton waste material and store it in the bin provided to store the waste cotton material. (Fig.2)
- Similarly store the each category of metal chip in separate bins.

Do not handle the chip by bare hand
There may be different metal chips. So separate the chip according to metal.

Each bin should have name of the material.

Identify the material given in fig 1 and fill in table 1

Table 1

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of the material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>
Hazard identification and avoidance

Objectives: At the end of this exercise you shall be able to
• identify the occupational hazards
• suggest suitable methods to avoid occupational hazards.

1. Working bare foot in shop floor
2. Using file without handle
3. Without wedge
4. Keeping scribe sharp edge open in pocket
5. Chipping metal surface with mushroom head chisel
CHIPPING ON METAL SURFACE WITHOUT SAFETY GOGGLES

LIFTING LOAD WITH DAMAGED SLINGS

NO OBSTACLE WHILE MOVING THE LOAD

LIFTING A LOAD WHILE PEOPLE WORKING NEARBY

STANDING BELOW A SUSPENDED LOAD

HAZARD IDENTIFICATION AND AVOIDANCE

Capital Goods & Manufacturing: Fitter - Exercise 1.1.05
Job Sequence

The instructor shall emphasise the importance of hazard and avoidance to the students and insist them to follow properly.

- Study the drawing of industrial hazards.
- Identify the type of hazards.
- Name the hazards against their names.
- Record the hazards and avoidance in Table 1.

Table 1

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Identification of hazards</th>
<th>Avoidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Get it checked by your instructor
Safety sign for danger, warning, caution and personal safety message

Objectives: At the end of this exercise you shall be able to
• identify the basic categories of safety sign
• record the meaning of safety sign in the table given.

IDENTIFY THE CATEGORIES
OF THE SAFETY SIGN
### Job Sequence

Instructor shall provide various safety signs, chart categories and explain their meaning, description. Ask the trainee to identify the sign and record in Table 1.

- Identify the safety sign from the chart.
- Record the name of the category in Table 2.
- Mention the meaning description of the safety sign in Table 1.

#### Table 1

<table>
<thead>
<tr>
<th>Fig. No.</th>
<th>Basic Categories/Safety sign</th>
<th>Meaning - description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Get it checked by your instructor.

**Capital Goods & Manufacturing : Fitter - Exercise 1.1.06**
Preventive measures for electrical accidents and step to be taken in such accidents

Objective: At the end of this exercise you shall be able to
• rescue a person from live wire.
**Job Sequence**

Disconnecting a person (mock victim) from a live supply (simulated)

1. Observe the person (mock victim) receiving an electric shock. Interpret the situation quickly.
2. Remove the victim safely from the ‘live’ equipment by disconnecting the supply or using one of the items of insulating material.

   **Do not run to switch off the supply that is far away.**
   **Do not touch the victim with bare hands until the circuit is made dead or the victim is moved away from the equipment.**
   **Push or pull the victim from the point of contact of the live equipment, without causing serious injury to the victim.** (Fig.1)

3. Move the victim physically to a nearby place.
4. Check for the victim’s natural breathing and consciousness.
5. Take steps to apply respiratory resuscitation if the victim is unconscious and not breathing.

![Fig 1](image_url)
Uses of fire extinguishers

Objectives: At the end of this exercise you shall be able to
• select the fire extinguisher according to the type of fire
• operate the fire extinguisher
• extinguish the fire.
Job Sequence

- Alert people surrounding by shouting fire, fire, fire when observe fire.
- Inform fire service or arrange to inform immediately.
- Open emergency exist and ask them to go away.
- Put "Off" electrical power supply.
- Do not allow people to go nearer to the fire
- Analyze and identify the type of fire. Refer Table 1.

Table 1

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 'A'</td>
<td>Wood, paper, cloth, solid material</td>
</tr>
<tr>
<td>Class 'B'</td>
<td>Oil based fire (grease, gasoline, oil) &amp; liquefiable solids</td>
</tr>
<tr>
<td>Class 'C'</td>
<td>Gas and liquefied gases</td>
</tr>
<tr>
<td>Class 'D'</td>
<td>Metals and electrical equipment</td>
</tr>
</tbody>
</table>

Assume the fire is 'B' type (flammable liquefiable solids)

- Select CO₂ (carbon dioxide) fire extinguisher
- Locate and pick up CO₂ fire extinguisher. Check for its expiry date.
- Break the seal. Fig1
- Pull the safety pin from the handle (Fig 2) (Pin located at the top of the fire extinguisher) (Fig 2)
- Aim the extinguisher nozzle or hose at the base of the fire (this will remove the source of fuel fire) (Fig 3)

Keep your self low
Squeeze the handle lever slowly to discharge the agent (Fig 4)

Sweep side to side approximately 15 cm over the fuel fire until the fire is put off. (Fig 4)

Caution
- While putting off fire, the fire may flare up.
- Do not be panic so long as it is put off promptly
- If the fire doesn't respond well after you have used up the fire extinguisher move your self away from the fire point.
- Do not attempt to put out a fire where it is emitting toxic smoke, leave it to the professionals.
- Remember that your life is more important than property. So don't place yourself or others at risk.

In order to remember the simple operation of fire extinguisher
Remember
P.A.S.S. This will help to use fire extinguisher
P for pull
A for aim
S for squeeze
S for sweep

Fire extinguishers are manufactured for use from the distance.
Practice and understand precautions to be followed while working in fitting jobs

Objectives: At the end of this exercise, you shall be able to
• record the precaution to be followed while working in fitting jobs.

PRECAUTIONS WHILE WORKING IN FITTING JOBS

1. OIL SPILLS ON SHOP FLOOR AND WORK TABLE
2. METAL CHIPS SPREAD ON SHOP FLOOR NEAR DRILLING MACHINE
3. HANDLING HOT JOBS WITHOUT GLOVES
4. MACHINE RUNNING WITHOUT BELT GUARD
5. CHANGING THE BELT WHEN THE SPINDLE IS ROTATING
<table>
<thead>
<tr>
<th>1</th>
<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>
<th>1.1.09</th>
</tr>
</thead>
</table>

**PRECAUTIONS WHILE WORKING IN FITTING JOBS**

Capital Goods & Manufacturing: Fitter - Exercise 1.1.09
The instructor shall guide and demonstrate the students to practice and understand precautions to be followed while working in fitting jobs.

- Record the precautions to be followed while working in fitting job in Table 1

### Table 1

<table>
<thead>
<tr>
<th>Fig. No.</th>
<th>Description</th>
<th>Record precautions to be followed while working in fitting job</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Fill up and get it checked by your instructor.

Scan the QR code to view the video for this exercise
Safe use of tools and equipments used in the trade

Objectives: At the end of this exercise, you shall be able to
• record the safety points while using the fitter trade tool and equipments.

FITTER TOOLS AND EQUIPMENTS
### Job Sequence

The instructor shall emphasise the students about the safe use of tools and equipment used in trade and guide them to record the safety points.

- Record the precautions to be followed while working in fitting job in Table 1

#### Table 1

<table>
<thead>
<tr>
<th>Fig. No.</th>
<th>Description</th>
<th>Record precautions to be followed while working in fitting job</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Fill up and get it checked by your instructor.

Scan the QR code to view the video for this exercise.
Identification of tools and equipments as per desired specifications for marking & sawing

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

- identify the marking tools used in fitting shop
- identify the sawing tools used in fitting shop
- record the names of tools in table.

<table>
<thead>
<tr>
<th>Fig 1</th>
<th>Fig 2</th>
<th>Fig 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fig 4</td>
<td>Fig 5</td>
<td>Fig 6</td>
</tr>
<tr>
<td>Fig 7</td>
<td>Fig 8</td>
<td>Fig 9</td>
</tr>
</tbody>
</table>

**Identification of Marking and Sawing Tools**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>01</td>
<td>1</td>
<td>1.2.11</td>
</tr>
</tbody>
</table>

**Scale:** 1:1

**Tolerance:**

**Time:** Shs

**Code No.:** FIN1211E1
Fig 10

Fig 11

Fig 12

Fig 13

IDENTIFICATION OF MARKING AND SAWING TOOLS

<table>
<thead>
<tr>
<th>1</th>
<th>-</th>
<th>-</th>
<th>-</th>
<th>01</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO.OFF</td>
<td>STOCK SIZE</td>
<td>SEMI-PRODUCT</td>
<td>MATERIAL</td>
<td>PROJECT NO.</td>
</tr>
<tr>
<td>1</td>
<td>1.2.11</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SCALE 1:1

TOLERANCE:

TIME: 5Hrs

CODE NO. FIN1211E1
Job Sequence

Instructor shall display all the tools and equipments in the section and brief their names, uses and the working condition of each tool and equipment

- Trainees will note down all the displayed tools names.
- Record it in table 1.
- Get it checked by the instructor.

Table 1

<table>
<thead>
<tr>
<th>Fig. No.</th>
<th>Name of the tool</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Selection of material as per application

Objectives: At the end of this exercise you shall be able to
• select the material for engineering application
• record it in the table.

Job Sequence

• Trainees will determine the type of material used for the purpose mentioned in the table.
• Record it in table 1.
• Get it checked by the instructor.

<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>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCALE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SELECTION OF MATERIAL AS PER APPLICATION

TOLERANCE: TIME: 1Hrs

CODE NO. FBM1212E1

30
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Part Name</th>
<th>Material used for manufacturing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vernier Caliper</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Scriber</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Hacksaw blade</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Protective coating on Iron and steel</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Worm wheels, Gears</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Casting of guns</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Bell</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Machine Bed casting</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Die block, hand tools</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>High speed steel</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Bolts and nuts</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Surface plate</td>
<td></td>
</tr>
</tbody>
</table>
Visual inspection of raw material for rusting, scaling, corrosion etc.

Objectives: At the end of this exercise you shall be able to
• visual inspection of raw material for rusting
• scaling and corrosion.

Fig.1 Rusted components
Fig.2 Corroded gears
Fig.3 Scalled part
Job Sequence

Instructor shall arrange to display various section of raw metals with rusting, scaling corroded conditions and without any defects.

Differentiate with one another

Ask the trainees to record it in the table

- Observe the given raw material
- Identify the formation of materials for rusting, corrosion and scaling
- Record the appearance of the defects in Table 1. Get it checked by the instructor

Table 1

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Defects on raw material</th>
<th>Brief the Appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Scaling</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Corrosion</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Rusted</td>
<td></td>
</tr>
</tbody>
</table>
Marking out lines, gripping suitably in vice jaws, hacksawing to given dimensions

Objectives: At the end of this exercise you shall be able to
• mark out lines using jenny caliper
• hold the job in bench vice
• cut along marked lines.
Job Sequence

TASK 1: Marking and hacksawing

- Check the pre-machined size of 75x75x10 mm using steel rule.
- Apply marking media cellulose lacquer evenly on the surface of the Job.
- Place the Job in levelling plate.
- Set the measurement 15 mm in Jenny caliper using steel rule.
- Draw parallel line of 15 mm to the side "AB" with the help of Jenny caliper as shown in Fig 1.
- Similarly, Set 30 mm, 45 mm and 60 mm and draw parallel lines to "AB". (Fig 1).
- Hold the Job firmly in Bench vice, keeping side "AD" parallel to vice Jaws.
- Select 1 mm pitch Hacksaw blade, fix the blade in hack saw frame, pointing teeth in the forward direction.
- Tighten the blade to the required tension with the wing nut.
- File a notch at the point of hacksawing to avoid slippage of the blade.
- Start cutting with a slight downward pressure using Hacksaw.
- Saw along the lines up to punch marks.
- Apply pressure in the forward stroke.
- Release the pressure in the return stroke.
- Use full length of the blade while sawing.
- Check the size with steel rule.

![Fig 1](image1)

- Punch witness marks on hacksawing lines using a dot punch and a ball pein hammer Fig.3

- Set the measurement 20 mm in Jenny caliper using steel rule.
- Draw parallel line to side "AD" using Jenny caliper.
- Similarly, set 30 mm, 40 mm and 50 mm and draw parallel lines to side "AD" as shown in Fig 2.

![Fig 2](image2)

TASK 2: Marking and hacksaw cutting

- Check the pre-machined size of 60x60x10mm using steel rule.
- Apply marking media cellulose lacquer evenly on the surface of the Job.
- Place the Job on levelling plate.
- Set the measurement 20 mm in Jenny caliper using steel rule.
- Draw parallel line of 20 mm to the side "AB" using jenny caliper Fig.1
- Similarly, with the same setting of the dimension 20 mm in Jenny caliper, draw parallel lines to "BC", "CD", and "AD". As shown in Fig 1.

![Fig 1](image3)
• Punch witness marks on the profile of Job using a dot punch and a Ball peen hammer as shown in Fig 2.

![Fig 2](image)

• Hold the Job firmly in Bench vice, keeping side "AD" parallel to vice Jaws. (Fig 3)
• Start cutting on side "AD", cut the line 1 to 2 upto the marked length 20 mm in right side. Fig.3

![Fig 3](image)

• In the same setting, without changing the position of the job cut the line 3 to 4 upto the marked length 20mm in left side as shown in Fig 3.
• Similarly, turn the job and cut the line 5 to 4, 6 to 7, 8 to7, 9 to 10, 11 to 10 and 12 to 2 as shown in Fig 4.

![Fig 4](image)

• After sawing profile of the Job shown in fig 5, check the size with steel rule.

![Fig 5](image)

Ensure that half of the punch marks to be visible while sawing.

Skill Sequence

Measuring with a steel rule

Objective: This shall help you to
• measure the length or a part of a length of objects.

Place the rule either directly on to the length to be measured or at right angle to the reference plane.
Use a contact face, if possible and read off measurements by looking at the steel rule directly. (Fig.1)
Measure with a rule starting off from the 1cm line if the edge of the rule is worn out or damaged. (Fig.2)

The rule must be held parallel to the edge of the work as otherwise the measurement will not be correct. (Fig.3)

Always keep the steel rule away from the cutting tools to avoid scratches/damages.

**Marking lines parallel to the edge of the job**

**Objective:** This shall help you to

- mark parallel lines using a jenny caliper.

Apply marking medium on the surface to be marked.

Set the jenny caliper to the size to be marked (i.e. dimension) with the help of a steel rule. (Fig.1)

Incline slightly and move the jenny caliper with uniform speed and mark lines.

Make witness marks on the lines marked using a 60° prick punch. The witness marks should not be too close to one another.

**Punching the marked line**

**Objective:** This shall help you to

- punch the line using prick punch.

Place the job on levelling plate, such that marked lines should be approximately perpendicular to the operator.

Hold the punch between the thumb and the first two fingers of the hand where possible, rest the little finger and the edge of your hand on the marked centre point as shown in Fig.1.

Bring up the dot punch in the vertical position and strike with a ball peen hammer on the head of the dot punch lightly.

Watch the point of the punch and strike its head with the ball peen hammer Fig.2. This dot punch marks prevent the wing compass leg from slipping while scribing curved lines from the centre point.
Sawing along a line

Objective: This shall help you to
• cut along a straight line by hacksaw.

Clamp the job to be cut according to the cross-section for sawing.
As far as possible hold the job in such a way that the flat or long side can be cut rather than the edge. (Fig.1)

In case the job has a profile (like steel angle), clamp the job so that sawing can be done towards the overhanging end. (Fig.2)

Clamp the job as long as possible on the vice and make sure that the marked sawing line is close to the side of the vice jaws in order to achieve maximum firmness.
Tighten the jaws firmly to avoid tilting and shifting of the job.
Whenever the section being cut shows chattering effect or vibration, the clamping needs improvement.
Select the correct pitch blade for cutting.
Shorter the cutting section is, finer the blade pitch. Make sure that atleast four teeth are cutting at a time.
Harder the material finer the blade pitch should be.
Fix the blade in such away that the teeth are in the direction of cut. (Fig.3)

Tighten and tension the blade by hand using only the wing nut.
Caution

Insufficient blade tension-cut will not be straight.
Over tension-blade will break.
File a notch at the starting point on smooth and hard jobs to avoid slipping of the hacksaw. (Fig.4)

Apply a little downward hand force as long as only a few teeth are cutting. Press down only during forward (cutting) stroke.
Use the full length of the blade in order to avoid early dulling of the teeth in the middle portion of the blade.
Move the blade strictly in line with the marked direction. Do not tilt the frame while sawing because bending of the blade can cause sudden breakage of the blade.
Resort to cutting from the opposite side in case the deviation from the marked line is excessive.

Slow down the cutting while completing the cut to avoid breakage of the blade and injury to yourself.

Scan the QR code to view the video for this exercise.
Sawing different types of metals of different sections

Objectives: At the end of this exercise you shall be able to
• cut different thickness of metals
• cut sections of metals.
**Job Sequence**

**TASK 1: Sawing on round rod**
- Check the raw material using steel rule.
- File the round to size Ø 25 x 100 mm.
- Remove the burrs from the edges.
- Apply marking media only where marking is required.
- Place the round rod on levelling plate.
- Use ‘V’ Block to support while marking the round rod.
- Punch witness marks on the sawing lines with dot punch.
- Hold the Job in bench vice.
- Fix 1.8 mm pitch hacksaw blade in hacksaw frame.
- File a notch at the point of cutting to avoid slippage of the blade.

**Selection of hacksaw blade**
- For soft materials use 1.8 mm pitch blade while sawing.
- For hard materials use 1.4 mm pitch blade while sawing.

**TASK 2: Sawing on steel angle**
- Mark and punch the sawing lines.
- Hold the job in bench vice as shown in Figure.1.
- Fix 1.8 mm coarse pitch blade in hacksaw frame.
- Cut along the sawing lines with hacksaw.
- Check the size of the angles with steel rule.

**Caution**
Select correct pitch blade according to the shape and materials to be cut.
While sawing, two or more teeth of blade should be in contact on metal section.

**TASK 3: Sawing on pipe**
- Mark and punch the sawing lines.
- Hold the job in bench vice as shown in figure.1.
- Fix 1.0 mm pitch blade in hacksaw frame.
- Cut along the sawing lines with hacksaw.
- Turn and change the position of the pipe while hack sawing.

**Caution**
Avoid over tightening the pipe in the vice which causes deformation.
Do not cut too fast.
Cut very slow and reduce pressure while cutting through.
Skill Sequence

Hacksawing (holding-pitch selection)

Objectives: This shall help you to
• select blades for different metal sections
• hold different sections of workpieces for hacksawing.

Holding the workpiece
Position the metal to be cut according to the cross-section for hacksawing.
As far as possible the job is held so as to be cut on the flat side rather than the edge or the corner. This reduces the blade breakages. (Figs 1, 2 and 3)

The selection of the blade depends on the shape and hardness of the material to be cut.

Pitch selection
For soft materials such as bronze, brass, soft steel, cast iron, heavy angles etc. use a 1.8mm pitch blade. (Fig.4)

For tool steel, high carbon, high speed steel etc. use a 1.4mm pitch. For angle iron, brass tubing, copper, iron pipe etc. use a 1mm pitch blade. (Fig.5)

For conduit and other thin tubing, sheet metal work etc. use a 0.8mm pitch. (Fig.6)
Hacksawing

Objectives: This shall help you to
• fix hacksaw blades by maintaining correct tension and direction
• cut metal pieces with a hacksaw.

Fixing of hacksaw blades

The teeth of the hacksaw blade should point in the direction of the cut and away from the handle. (Fig.1)

The blade should be held straight, and correctly tensioned before starting.

While starting the cut make a small notch. (Fig.2)

File ‘V’ notch using a triangular file.

The cutting movement should be steady and the full length of the blade should be used.

Apply pressure only during the forward stroke. (Fig.3)

At least two to three teeth should be in contact with the work while cutting. Select a fine pitch blade for thin work. (Fig.4 & 5)

Turn and change the position of the pipe while hacksawing. (Fig.4 & 5)

Normally, a coolant is not necessary while hacksawing by hand. However, to saw in heavy stock, intermittent coolant to be applied.

Do not move the blade too fast. While finishing a cut, slow down to avoid breakage of the blade and injury to yourself and others.

Scan the QR code to view the video for this exercise
Filing channel, parallel

Objectives: At the end of this exercise you shall be able to
• hold the job in a bench vice horizontally for filing
• file a flat surface with a flat bastard file
• check the flatness of the filed surface with a straight edge/blade of a try square
• check the parallelism with an outside caliper & steel rule.
Job Sequence

- Check the stock size with a steel rule.
- Hold the job in bench vice, so that surface S1 comes on top. (Fig 1)
- **Apply only limited clamping force so that the ribs do not bend**
- Mark 35 mm line on surface S2 and S3 parallel to S1 with a jenny caliper.
- File the rib up to the marked line (Fig 2) and check the size with steel rule.
- Check the surface level with the straight edge.
- Check the parallelism with an outside caliper and steel rule.

Skill Sequence

Filing flat surface

**Objective:** This shall be help you to
- file flat

Check the height of the bench vice. (Fig 1) If the height is more, use a platform and if it is less, select and use another workbench.

- Hold the surface S1 with a flat bastard file.
- Check the surface level with straight edge/blade of a try square.

Check whether the handle of the file fits tightly. Hold the handle of the file (Fig 2) and push the file forward using your right hand palm or left hand palm.

Hold the tip of the file according to the quantity of the metal to be removed.

For heavy filing. (Fig 3)
For light filing. (Fig 4)

Use the blade of the try square as a straight edge for checking flatness.
Place the blade of the try square on the surface to be checked in all directions so as to cover the entire surface.
Do the checking facing the light. Light gap will indicate high and low spots.

Checking squareness:
Consider the large finished surface as the reference surface. Ensure that the reference surface is filed perfectly and is free from burrs.
Butt and press the stock against the reference surface. (Fig 2)

For removing local uneveness. (Fig 5)

Start filing by pushing the file uniformly during the forward stroke and release the pressure during the return stroke.
Continue giving strokes. Balance the pressure of the file in such a way that the file always remains flat and straight over the surface to be filed.

Checking flatness and squareness

Objectives: This shall help you to
- check flatness
- check squareness.

Checking flatness (Fig 1)

Use the blade of the try square as a straight edge for checking flatness.
Place the blade of the try square on the surface to be checked in all directions so as to cover the entire surface.
Do the checking facing the light. Light gap will indicate high and low spots.

Checking squareness:
Consider the large finished surface as the reference surface. Ensure that the reference surface is filed perfectly and is free from burrs.
Butt and press the stock against the reference surface. (Fig 2)

For removing the local unevenness draw filing can also be done. (Fig 6) The same filing can also be done for fine finishing.
Measuring with outside calipers

Objective: This shall be help you to
• select the right capacity caliper for measurement
• set the sizes both in firm joint and spring calipers
• read the sizes by transferring them to a steel rule or other precision measuring devices as the case may be.

Outside calipers: Select a caliper based on the dimension to be measured.

A 150mm capacity outside caliper is able to measure sizes from 0-150mm.

Open out the jaws of the calipers until they pass clearly over the dimension to be measured. The work must be stationary when measuring the sizes. (Fig.1)

Place one point of the leg over the workpiece and get the sense of feel of the other point of the leg.

If there is clearance on the other point of the leg, gently tap the back of one leg of the firm joint calipers on a wooden piece until it just slips from the external diameter of the workpiece to give the right sense of ‘feel’. (Fig. 2)

Because the accuracy of reading the sizes depends mainly upon the sense of feel of the user, high care should be exercised to get the correct ‘feel’.

In the case of spring outside calipers, adjust the screw nut so that the adjustment of the jaws just slips from the external diameter of the workpiece to give the right sense of feel. (Fig.3)

When you have adjusted the outside caliper for the correct ‘feel’ transfer the measurement to a steel rule or any other precision measuring instrument as the case may be.
Keep the graduated steel rule on a flat surface and hold the point of one jaw firmly against the rule end. (Fig.4)

The point of one jaw must be placed over the graduation so that the point of the other jaw is parallel with the edge of the steel rule.

Record the reading to an accuracy of ±0.5mm.
Similarly take measurement at middle and at the end. If all the dimensions are equal then it is parallel.
Objectives: At the end of this exercise you shall be able to
• hold the job in a bench vice horizontally for filing
• file a flat surface
• check the flatness of filed job using straight edge/try square blade
• check the squarness of the job with trysquare.
Job Sequence

- Check the raw material size using steel rule.
- Remove the scaling by flat rough file.
- File side (A) with flat bastard file (fig 1)
- Check the flatness by blade of a try square
- File side (B) and maintain the squareness with respect to side (A).
- Check the squareness with a try square.

The side A, B and C are mutually perpendicular to each other (Fig 1)

- Set Jenny caliper to 74 mm using steel rule
- Draw parallel lines of 74 mm to side (B) and (C)

- Check the dimensions with a steel rule and squareness with a try square
- File surface (F) and maintain the thickness of 9 mm parallelism to side A.
- Remove sharp edges. Apply little amount of oil and preserve it for evaluation.

- Punch the marked line using dot punch and ball pein hammer
- Set and file sides (D) and (E) to 74 mm and maintain squareness to all other sides.
- Maintain (D) and (E) parallel to side (B) and (C) (Fig. 2)

Scan the QR code to view the video for this exercise
Filing practice, surface filing, marking of straight and parallel lines with odd leg caliper and steel rule

Objectives: At the end of this exercise you shall be able to
• file and finish the flat to the required size
• mark lines using odd leg caliper
• punch the marked lines.

NOTE: Use same material for both the markings (Side A & B)
**Job Sequence**

**Mark on side A**
- Check the raw material size using steel rule.
- File 3 sides mutually perpendicular to each other.
- Mark and file to size 48x48x9 mm.
- Set 5 mm in odd leg caliper and draw parallel lines to all sides (Fig 1).

**Mark on side B**
- Set 5 mm in odd leg caliper and draw parallel lines to side AB, CD, CA and DB Fig 2.
- Set 10 mm and draw parallel lines to side AB and CD.
- Mark 5 mm on line 1 and 2, 3 and 4 as shown in fig.3.

**Fig 2**
- Similarly, set 10mm in odd leg caliper and draw parallel lines to all sides. (Fig 2) Punch on the marked line.

**Fig 5**
- Join point 1 and 3, 2 and 4, and punch witness marks as shown in fig 5.
- Apply little oil and preserve it for validating the marking.

**Fig 4**

52  
Capital Goods & Manufacturing - Fitter : Exercise 1.2.18
Marking practice with dividers, odd leg calipers and steel rule (circles, arcs, parallel lines)

Objectives: At the end of this exercise you shall be able to
- mark parallel lines with jenny caliper
- mark angular lines with a protractor and scriber
- mark arcs, circles and tangents with divider and scriber.

NOTE: Use same material for both the tasks (side A & B)
Job Sequence

**TASK 1: Marking curves & circles**

- Check the raw material size using steel rule
- File the raw material to size 78x78x9 mm
- Apply marking media cellulose lacquer on the surface of the Job.
- Set the dimension 13 mm in Jenny caliper and draw parallel line as per drawing with reference to 'xy'. Fig 1
- Similarly, set the dimensions 26 mm and draw parallel line Fig 1

**Step 2**

- Draw parallel line of 17 mm from side x (Fig 3).

**Step 3**

- Set the dimension 11 mm in Jenny caliper and draw parallel line as per drawing with reference to 'xz'. Fig 2
- Similarly, set the dimensions 39 mm, 67 mm and draw parallel lines.Fig 2

**Step 4**

- Punch on the intersecting point of centre lines to draw circle and radius using prick punch 30°
- Set the radius 5 mm, 6 mm in divider and draw circles, as per drawing.
- Set the radius 35 mm and draw arc as per drawing.
- Punch witness marks on the circles and radius.
- Preserve it for evaluation.

**TASK 2: Marking tangents & arcs**

**Step 1**

- Check the material for its size and its squareness
- Apply marking media on one face of the job.

**Step 2**

- Mark 21 mm and 61 mm from side y on the marked parallel line (Fig 3).
- Set 97° on the bevel protractor
- Mark 97° line through point 'O' and set the centres of other two circle
- Punch centre marks on all four circles

**Step 3**

- Draw Ø6 mm circle at 'a', 'o', 'c' and Ø4 mm circle at 'b'.
- Draw tangent lines to join x, y and z as shown in fig.4

**Step 4**

- Draw an arc, R8 mm from the centre 'a' and 'o'
- Draw an arc, R10 mm from the centre 'c'.
• Draw the tangent lines from the arc drawn, the intersection of the tangent (e) is the centre for joining the tangent with arc.
• Draw R10 mm arc from the centre at point ‘f’ as shown in fig.4
• Similarly, draw R6 mm arc at point ‘d’

**Step 5**
• Punch on the marked lines with equal intervals Fig 5.
• Preserve the job for evaluation.
Marking off straight lines and arcs using scribing block and dividers

Objectives: At the end of this exercise you shall be able to
• mark parallel lines using scribing block
• mark arcs using dividers.

NOTE: Use same material for marking Task 1 & 2

<table>
<thead>
<tr>
<th>TASK 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 x R20</td>
</tr>
<tr>
<td>18</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>76</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TASK 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ø 12 x 2 CIRCLES</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>38</td>
</tr>
<tr>
<td>76</td>
</tr>
</tbody>
</table>

NOTE: Use same material for marking Task 1 & 2
Job Sequence

TASK 1: Marking straight lines & arcs

- Check the raw material size using steel rule.
- File three sides mutually perpendicular to each other.
- Mark and file to size of 76 x 76 x 9 mm
- Clean Marking Table, Angle plate, Scribing block and Steel rule with soft cloth.
- Place Scribing block, Angle plate and Steel rule on marking table.
- Support the Steel rule along with Angle plate.
- Set the dimension 28 mm in scribing block using Steel rule.
- Support the Job along with angle plate and scribe dimension line 28 mm in scribing block with reference to side ‘AB’ Fig 1.

- Similarly, set 48 mm and scribe line with reference to side ‘AB’.
- Turn and place the Job with reference to side ‘BC’.
- Set the size 18 mm and scribe line with reference to side ‘BC’ Fig 2.

- Similarly, set the size 58 mm and scribe line with reference to side ‘BC’.

![Fig 1](image1)

![Fig 2](image2)

- Set the size 20 mm and scribe line with reference to all over the four sides to draw radius.
- Punch on the four radius point with a 30° prick punch.
- Draw 20 mm radius using divider in four corners.
- Punch on the marked lines with equal intervals.
- Preserve it for evaluation.

![Fig 3](image3)

- Similarly, set 48 mm and scribe line with reference to side ‘AB’.
- Mark radius R6 on the 6 place.
- Join radius lines as per drawing.
- Draw ∅12mm circle on the marked reference of 20mm and 30mm.
- Mark corner of the centre R10mm.
- Punch on the mark line by 60° dot punch.

- Mark the centre line 38 mm from reference surface AB.
- Mark 15 mm above the centre line and 15 mm below the centre line as per drawing.
- Mark 20 mm and 30 mm on the centre line draw reference surface AD.

TASK 2: Marking straight lines, arcs & edges

On other side of job, mark and punch TASK 2 as per drawing.

- Mark radius R6 on the 6 place.
- Join radius lines as per drawing.
- Draw ∅12 mm circle on the marked reference of 20 mm and 30 mm.
- Mark corner of the centre R10 mm.
- Punch on the mark line by 60° dot punch.
Skill Sequence

Marking parallel lines using surface gauge

Objective: This shall help you to

• Mark parallel lines using a surface gauge
  
Check the free movement of the scriber and other sliding units.

Clean the base of the surface gauge.

Keep the base firmly on the surface plate.

Rest the steel rule against the angle plate and set the scriber to the size to be marked. (Fig 1)

Make sure that the job has no burrs and has been properly cleaned.

Apply a thin and even coating of the marking media.

Butt the job against the angle plate.

Hold the job in one hand and move the scriber point touching the surface across the work and mark. (Fig 2)
Chipping flat surfaces along a marked line

**Objective:** At the end of this exercise you shall be able to
• chip surfaces evenly using a flat chisel.

**Note:** Each trainee should practice chipping of 3 layers of 1.5 mm deep.

---

**Job Sequence**

- Apply marking media and mark the depth of metal to be removed by chipping.
- Punch the marked line with a dot punch.
- Hold the job firmly in the vice.
- Support the job with wooden block while chipping.

**If necessary give a wooden support below the work piece so that the marked line should be above the vice jaw face.**

- Select a flat chisel 20 mm width with a proper cutting edge.
- Select a ball pein hammer of 1 kg.
- Hold the chisel at approximately 35° angle of inclination in chipping position.
- Hold the hammer at the end of the handle to get more leverage.

**Caution:** Chisel should be free from mushroom head.

Hammer handle should be securely fixed with eye hole with a wedge.

Use goggles while chipping.

Use a chipping guard behind the vice to arrest the flying chips.
Skill Sequence

Chipping using flat chisel

Objective: This shall help you to
• chip metal pieces.

Before commencing chipping: Select a mushroom-free chisel and choose a hammer with a well secured handle. (Fig 1)

Wipe off oily substances, if any, from the face of the hammer.
Wear safety goggles.
Install the chipping screen. (Fig 2)

Chipping process: Hold the work in a vice. If necessary, support the work on a wooden block. (Fig 3)

Position the chisel at an angle 35° (approximately) to cut the metal in uniform thickness. (Fig 4)
Hammer the head of the chisel by looking at the point of the chisel. (Fig 4)

Hold the hammer at the end of the handle for maximum leverage. (Fig 5)
Stop chipping before the end of the surface; otherwise the edge of the job will break off. To prevent this, chip the end of the job from the opposite direction. (Figs 6A & B)

Scan the QR code to view the video for this exercise
Marking, filing, flat square and check using Try - square

Objectives: At the end of this exercise you shall be able to
• hold the job in a bench vice horizontally for filing
• file flat and square and maintain the sizes within ±0.5mm
• check the flatness of filed job using straight edge try square blade
• check the squareness of the job with try square.

Job Sequence

• Check the raw material size using steel rule.
• File 3 sides mutually perpendicular to each other.
• Mark and file to size 70x70x18mm by maintaining the size ±0.5mm.
• Check the size with steel rule
• Check the squareness with try square and flat surface with straight edge/blade of try square.
• Clean and apply oil and preserve it for evaluation.

FILING FLAT AND SQUARE
Marking according to simple blue prints for locating position of holes, scribing lines on chalked surfaces with marking tools

Objectives: At the end of this exercise you shall be able to
- mark drill holes and radius using divider
- mark angular lines using bevel protractor
- mark straight lines using marking block
- mark pitch circle diameter using divider.
NOTE: Use both the surfaces of metal for Fig 1, 2, 4 and 5
Job Sequence

Figure: 1
- Check the raw material size using steel rule.
- File raw metal to size 70 x 45 x 9mm and check with steel rule.
- Apply marking media on the surface of the job.
- Mark circular holes centre, radius and groove as per drawing using a Jenny caliper.
- Set the radius of 5 mm in divider and draw circles Ø 6 mm, Ø 8 mm, and Ø 16 mm as per drawing.
- Punch witness marks on marked line using a dot punch.
- Check the marking with steel rule.

Figure: 2
- Apply marking media on the another surface of the job.
- Mark 8mm, 16mm, 26.4 mm and 34.4 mm lines using Jenny caliper with reference to ‘xy’.
- Mark 8mm, 34 mm and 52.4 mm lines using Jenny caliper with reference to ‘xz’. fig 1.
- Set the radius 3 mm in divider and draw circles Ø 6mm 3 holes at point ‘A’, ‘O’ and ‘B’.
- Similarly, set the raidus 8 mm and draw half round as shown in Fig 2.
- Draw tangent line as shown in Fig 2.
- Draw external radius 8mm, from point ‘C’ with references to tangent lines.
- Draw radius 8 mm at point ‘o’ to join tangent lines.
- Punch the witness marks on profile of the drawing.
- Check the marking with steel rule.

Figure 3
- Apply marking media.
- Mark holes centre line using a Jenny caliper as per drawing.
- Set the radius 3 mm, 3.5mm, 2.5 mm, 8 mm and 15 mm and draw holes and circle as per drawing.
- Punch to locate the centre of hole using prick punch 30°.
- Check the location of hole centres using steel rule.

Figure 4
- Apply marking media.
- Mark lines as per drawing.
- Set radius 58 mm in divider and draw radius as per drawing.
- Set radius 6 mm and 3 mm draw circle and curve.
- Punch on the peripheral of circle for prominent mark.
- Punch witness marks on the marked lines using dot punch 60°.
- Check the marking using steel rule.

Figure 5
- Apply marking media.
- Mark lines as per drawing.
- Draw holes, radius using divider.
- Punch on the peripheral of circle for prominent mark.
- Punch witness marks on the marked lines using dot punch 60°.
- Check the marking with steel rule.
Finding center of round bar with the help of 'V' block and marking block

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

• select appropriate sizes of 'V' block to hold round bar
• find the centre of round bar using 'V' block and marking block.
Job Sequence

- File the faces of round bar
- Apply marking media on a face of round bar
- Clean marking table, 'V' block, marking block and steel rule
- Place 'V' block, marking block and steel rule on marking table.
- Set the round bar on 'V' block and clamp it with 'U' clamp.
- Place the marking block scriber on top of the round bar and read measurement in steel rule.
- Measure the height of round bar using steel rule
- Set the measurement in marking block using steel rule lesser than 10mm from the top of the round bar reading.
- Scribe line 'AB' on face of round bar using marking block as shown in fig 1.

- Loosen the 'U' clamp
- Rotate and set the job to 90° using try square and Tighten the 'U' clamp and scribe line BC (Fig 2).

- Repeat the same procedure to scribe lines CD and AD fig 3.

- Loosen the 'U' clamp and take out the round bar outside and keep it on marking table.
- Join the coordinate points 'AC' and 'BD' using steel rule and scriber fig 4.

- Punch on the intersecting point 'O' using centre punch 90°.
- Point 'O' is the centre of round bar.
- Preserve it for evaluation.
Exercise 1.2.25

Joining straight line to an arc

Objectives: At the end of this exercise you shall be able to
- mark lines on metallic surfaces with marking block
- mark lines with scriber
- mark angles with bevel protractor
- bisect the angles with divider
- draw circles, arcs and tangents with divider and scriber
- register the profile with dot punch.

Task 1

Task 2

<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>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>65 ISF 10-155</td>
<td>-</td>
<td>Fe310</td>
<td>-</td>
<td>TASK 1</td>
<td>1.2.25</td>
</tr>
<tr>
<td>1</td>
<td>ISST 100 x 2-140</td>
<td>-</td>
<td>-</td>
<td>TASK 2</td>
<td>1.2.25</td>
<td></td>
</tr>
</tbody>
</table>

SCALE 1:1

TOLERANCE: ±0.5mm

TIME: 25Hrs

CODE NO. FIN1225E1
Job Sequence

TASK 1: Spanner

- Check the raw material size using steel rule.
- File metal to size 150 x 64 x 9 mm.
- Apply marking media on the surface of the job.
- Clean marking table, marking block, angle plate and steel rule.
- Set the size 30 mm in marking block using steel rule.
- Place the job on marking table and support it with angle plate.
- Mark centre line datum 30 mm with reference to side ‘WX’ Fig 1.
- Set the size 30 + 5 = 35 mm in marking block and scribe a line right side to 19 mm length as shown in job drawing with reference to side ‘WX’ Fig 1.
- Similarly, set the size 30 - 10 = 20 mm and scribe a line in right side to 23 mm length as shown in job drawing with reference to side ‘WX’ Fig 1.
- Turn the job and support it with angle plate with reference to side ‘XY’ Fig 2.
- Set the size 19 mm and scribe a line with reference to side ‘XY’ and mark point ‘A’ at the intersecting line. Fig 2
- Similarly, scribe a line to size 20 mm with reference to side ‘XY’ and mark point ‘B’ at the intersecting lines. Fig 2
- Set the radius 19 mm and draw radius at point ‘A’.
- Radius line intersect the object reference side ‘XY’ at point ‘C.’ Fig 3
- Mark 14° angle at point ‘C’ using bevel protractor and scribe a Angular line to the distance 27 mm and mark point ‘D’. Fig 3
- Mark 90° Angular line with reference to line ‘CD’ to the distance 22 mm and mark point ‘E’ as shown in the job drawing. Fig 4
- Similarly, mark 90° Angular line with reference to line ‘DE’ to the distance 27 mm and mark point ‘F’. Fig 4
- Mark the centre line on line ‘DE’ and name it as ‘G’. Fig 5
- From point ‘G’ draw a perpendicular line to the length of 19 mm downward and mark it as ‘H’. Fig 5
- Draw radius of 19 mm from the point ‘H’ in such a way that the arc should meet point ‘E’ and ‘D’ through centre point ‘G’. Fig 5

Fig 1

Fig 2

Fig 3

Fig 4

Fig 5
• Set the radius 19 mm and draw an arc at point 'B'.
• Radius line intersect the object reference side ‘XY’ at point ‘F’. Fig 5
• Scribe a line 30 + 9.5 = 39.5 mm horizontal line with reference to side ‘WX’. Fig 6
• Similarly, scribe a line 30 - 9.5 = 20.5 mm horizontal line with reference to side ‘WX’ to mark the width of spanner in right end. Fig 6
• Join the spanner object lines by drawing a radius of 13 mm from point ‘Q’ in downward side and radius 51 mm from point ‘R’ in upward side and complete the spanner as shown in job drawing. Fig 6

Similarly, follow the above procedures to mark the left side end of the spanner from points I, J, K, L, M, N, O, P, S and T to complete the spanner profile marking. Fig 7

• Punch on the marked lines for prominent marks. Fig 8
• Check the size with steel rule.

**TASK 2: Profile**

- Check the metal sheet with steel rule
- Planish the sheet (raw material) straight and flat.
- File and finish the size to 135 x 83 x 2mm.
- Check the size with vernier caliper and squareness with try square.

**Marking**

- Apply marking media cellulose lacquer on flat surface.
- Place the surface BC on the surface plate and support against the angle plate.
- Set the vernier height gauge to 5mm and scribe a line.
- Similarly, set all the other horizontal dimensions in Fig.1 and draw horizontal lines.
- Place the surface ‘AB’ on the marking table and set vertical dimensions as in Fig 1 and draw lines.
MAKING A TEMPLATE
MAKING A TEMPLATE
Skill Sequence

Marking with a vernier height gauge

Objective: This shall help you to
- mark with a vernier height gauge.

What is the main function of the vernier height gauge?
One of the primary functions of the vernier height gauge is to scribe lines on a workpiece to known heights.

How to use a vernier height gauge?
The height gauge scriber must be checked against the reference surface to confirm whether the zero of the vernier coincides with the zero of the beam scale when the scriber contacts the reference surface. (Fig.1)

Check for free movements of the sliding unit.

Make sure that the workpiece has no burr and has been properly cleaned.

Workpiece necessitates clamping to an angle plate. If thin, the application of the marking media should be light thin and even.

Keep the vernier height gauge base firmly on the surface plate.

Hold the scriber at an angle to the workpiece and pull the corner of the scriber across the work. (Fig.2)

Ensure the scriber point is sharp always. Sharpen only the inclined surface of the scriber point. (Fig 3)

Frequent sharpening should be avoided. Ask the instructor to sharpen the scriber for you.

Do not allow the base to lift.

Do not apply too much pressure to peel off metal from the workpiece. This will avoid damage to the scriber point. Centre points can be located by scribing lines at right angles.

Scribe first all lines of dimensions in one direction. Secondly scribe all the lines in another direction. (Fig 2).

Precautions to get exact lines.

Place the work at 90° and scribe the lines to work. Job surfaces should be finished flat and smooth to avoid lifting during marking.

Fig 1

Fig 2

Fig 3
Chipping, chamfering, chip slots and oil grooves (straight)

Objectives: At the end of this exercise you shall be able to
• mark slot, groove and chamfer as per drawing
• chip slot with cross cut chisel by maintaining the dimensions
• chip oil groove with round nose chisel and maintaining dimensions
• chip angular surface using flat chisel.

<table>
<thead>
<tr>
<th>1</th>
<th>50 ISF 10-72</th>
<th>-</th>
<th>Fe310</th>
<th>-</th>
<th>-</th>
<th>1.2.26</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO.OFF</td>
<td>STOCK SIZE</td>
<td>SEMI-PRODUCT</td>
<td>MATERIAL</td>
<td>PROJECT NO.</td>
<td>PART NO.</td>
<td>EX. NO.</td>
</tr>
<tr>
<td>SCALE 1:1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CHIPPING SLOT AND DIL GROOVE

TOLERANCE: TIME: 10Hrs

CODE NO. FIN1226E1
Job Sequence

- Check the raw material size with steel rule
- File and finish the raw metal to size 70x48x14 mm.
- Mark the Job as per drawing and punch the witness mark with dot punch 60°.

Chipping straight slot

- Hold the job in bench vice firmly.
- Chip the slot using cross cut chisel and maintain the dimension 9.5 mm width to the depth of 5 mm. Fig 1.

Keep a rag soaked in lubricating oil handy for intermittent cooling of the cutting edge of chisel.

- Chip the corners of the slot using diamond point chisel fig 2.

Chipping oil groove

- Similarly, chip oil groove width 3 mm x depth 3 mm with round nose chisel and Ball pein hammer fig 3.
- Check the width and depth of slot and oil groove with steel rule and depth gauge.
- Chip the chamfered portion 5 x 45° using flat chisel and a Ball Pein hammer as shown in job drawing.
- De - burr all the faces and corners of the Job.
Filing flat, square and parallel to an accuracy of ±0.5mm

Objectives: At the end of this exercise you shall be able to
- file flat, parallel surfaces within an accuracy of ±0.5mm
- check dimensions with steel rule
- check parallelism with an outside caliper
- check right angle with try square.

FILING FLAT AND SQUARE (PARALLEL BLOCK)
Job Sequence

- Remove burrs and check the size of the raw material.
- File diagonally (Fig.1) side 1 with a 350mm flat bastard file.
- Frequently check the flatness with a try square blade.
- File the same side with a flat second cut file and finish with a flat smooth file.
- File sides 2, flat and at 90° to side 2 and side 1.
- File sides 3, flat and at 90° to side 2 and side 1.
- Mark sizes as per drawing.
- File side 4 parallel to side 1. (use a caliper to check parallelism.)
- File and finish side 5 parallel to side 2.
- File and finish side 6 parallel to side 3.
- Check the size with steel rule.

Remove the hard surface scale from the surface to be filed, using the edge of a flat bastard file.

- Clean, apply little oil and preserve it for evaluation.

![Fig.1](image-url)
Objective: At the end of this exercise you shall be able to

- chip curve on flat bearing surface with uniform round nose chisel
- chisel/half round chisel
- chip keyways at various angles with cross cut and diamond point chisel.

Task 1

Task 2

Chipping Key Ways at Various Angles
Job Sequence

TASK 1: Chipping oil groove.
- Check the raw metal with steel rule
- File and finish the raw metal to size 70 x 45 x 9mm
- Mark the oil groove curve as per drawing.
- Chip the oil groove with round nose chisel maintaining the dimension width 3 mm. (Fig .1)

- Check the keyway size with steel rule.

TASK 2: Chipping keyways at various angles
- Check the raw metal for its size
- File to size 70x48x9 mm
- Check the size with vernier caliper
- Check the squareness with try square
- Apply marking media and mark keyways using vernier height gauge and keyway angles using vernier bevel protractor. (Fig 2)

- Punch witness marks
- Hold the job in bench vice
- Chip keyways with cross cut chisel to the required depth
- Chip keyways sharp corners with a dimond point chisel
- Check the job size with vernier caliper
- Check the anlges with vernier bevel protractor
- Finish the job and deburr it.
- Apply thin coating of oil and preserve it for evaluation

Grind the chisels well
- Look always at the cutting edge
- Cool the cutting edge from time to time

Skill Sequence

Measuring angles with vernier bevel protractor

Objective: At the end of this exercise you shall be able to
- measure angles with the vernier bevel protractor

How to use a vernier bevel protractor?
The vernier bevel protractor setting depends on the type of angle to be measured. It can be set in different ways for measuring and checking angles. (Fig 1 to 8)

Before measuring, check and ensure that the measuring surfaces (the blade and stock of the protractor) are not damaged.

Clean the measuring faces of the protractor and the workpiece. Use a soft clean cloth.

While measuring, loosen the vernier scale locking screw.

Loosen the blade locking screw, adjust the blade to suit the workpiece, tighten the blade screw and place the protractor on the work surface.

Adjust the protractor so that the inner surface of the blade and the base are in contact with the workpiece.

How to set a vernier bevel protractor properly on a workpiece?
Make sure that the protractor is perpendicular to the surface being measured.

The protractor must be adjusted so that the blade and the base are in full contact with the surfaces being measured. (There should be no gap between the blade, the base and workpiece surfaces.)

Lock the vernier locking nut carefully and remove the vernier bevel protractor and take the reading.

When you have finished measuring, clean the protractor using a soft cloth, and put it back in its case.

Do not leave the protractor in a place where it could fall, or be otherwise damaged.
Sharpening of chisel

Objectives: At the end of this exercise you shall be able to
• re-sharpen the flat chisel using pedestal/bench grinder
• operate safely the pedestal or bench grinding machine.

NOTE: Instructor shall provide chisels for resharpening
Skill Sequence

Grinding of flat chisel

Objective: This shall help you to
• grind a flat chisel when they become blunt.

Before grinding: Check the grinding wheel by,

– sliding the finger tip across the grinding wheel to detect glazing
– (In case of glazing, dress the wheel.) For dressing use silicon carbide sticks and seek the help of the instructor. (Fig 1)
– visually check for cracks.

Switch on the grinder, stand by the side of the wheel for safety, and see whether the wheel runs ‘true’ and has no excessive vibration. In case of excessive vibration, truing is necessary. Ask the instructor for advice.

Ensure that there is enough coolant in the container.

Protect your eyes with goggles or lower the protecting shield near the tool rest. (Fig 2)

Adjust the tool rest 2 mm closer to the wheel, if necessary. (Fig 2)

During grinding: Take a blunt chisel for re-grinding. Chisels will become blunt due to use. For efficient chipping, chisels are to be re-sharpened regularly.

Do not use cotton waste or other material for holding the chisel while grinding.

Use only the face of the wheel and not the sides (Fig 3)

Switch on the grinder.

Hold the chisel edge parallel to the wheel surface; the body of the chisel must be at an angle of 30° in such a way as to get 60° wedge angle. (Fig 5)

Rest the body of the chisel on the tool rest (A) (Fig.5) and allow the point to touch the wheel. (Figs 4 & 5)
Keep the pressure as minimum as possible to prevent excessive heating of the cutting edge, (avoid blue colour i.e. annealing effect).

Rock the point on both sides in an arc to provide convexity at the cutting edge. (Fig 5) See the arrows 'C'.

Dip the chisel in the coolant as and when it is required so as to avoid overheating.

Repeat the grinding on the opposite side of the cutting edge.

Check the wedge angle with a bevel protractor.
File thin metal to an accuracy of 0.5mm

Objectives: At the end of this exercise you shall be able to
• file surfaces flat and square within ±1mm using flat bastard and second cut file
• clamp the workpiece in the bench vice
• clean the files using file card to remove pinnings
• scribe lines parallel to reference surfaces using a scriber
• punch witness marks on scribed lines with a dot punch
• check flatness and squareness using a try-square
• check thickness using an outside caliper.

Job Sequence

• Remove burrs, if any using a flat second cut file and ensure the metal surface is free from oil or grease.
• Check the raw material for its size with a steel rule 300mm.
• Hold the workpiece in a 125mm jaw bench vice on its ends.
• Ensure the work is held horizontally.

Do not over-tighten the workpiece.

• File the top surface with a flat bastard file 250mm.
• Check flatness with a try-square.
• File to medium finish using a flat second cut file 250mm.

• Hold the workpiece to file the longer side.
• File and check flatness and squareness with previously finished surfaces using a try-square 150mm.
• File the adjacent shorter side flat and square to both the finished surface.
• Remove burrs and mark sizes as per job drawing, using a steel rule, try-square and scriber.
• File the other two sides flat and square, maintaining the dimensions.

Use soft jaws to protect the finish filed surface while holding the workpiece in the benchvice.

• File the other flat surface parallel and check the thickness using an outside caliper.

<table>
<thead>
<tr>
<th>1</th>
<th>65 BSF 6 x 105</th>
<th>Fe310-O</th>
<th>-</th>
<th>-</th>
<th>1.2.30</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO.OFF</td>
<td>STOCK SIZE</td>
<td>SEMI-PRODUCT</td>
<td>MATERIAL</td>
<td>PROJECT NO.</td>
<td>PART NO.</td>
</tr>
<tr>
<td>SCALE 1:1</td>
<td>FILING THIN METAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DEVIATIONS ±0.5mm  TIME: 10h

CODE NO. FIN1230E1
Cleaning files

Objective: This shall help you to
• clean files.

Introduction
During filing, the metal chips (Filings) will clog between the teeth of the files. This is known as ‘pinning’ of files. Files which are pinned will produce scratches on the surface being filed, and also will not bite well.
Use a file brush to remove pinning of the files. (Fig.1)

Pull the file brush along the direction of the overcut.
Take out the filings which do not come out easily by the file card by a brass or copper strip. (Fig.2)

Use only soft metal strips (brass or copper) for cleaning new files.

The sharp cutting edges of the files will wear out quickly if a steel file card is used.

Clean the file frequently in order to remove the filings embedded in chalk powder.

When filing a workpiece to a smooth finish more ‘pinning’ will take place because the pitch and depth of the teeth are less.
Application of chalk on the face of the file will help reduce the penetration of the teeth and ‘pinning’.

File Brush

D swingers

Fig 1

Fig 2

[Diagram of file brush and metal strips]
Saw along a straight line, curved line, on different sections of metals

Objectives: At the end of this exercise you shall be able to
• saw in straight line on different sections of metals, channel and ‘T’ section
• saw in curved line on flat section of metal.

NOTE: USE EX.NO: 1.2.16 FOR TASK 1
Job Sequence

TASK 1: Hacksawing on channel
- Check the material to size.
- Apply marking media on the surface.
- Mark the required number of saw cut with a jenny caliper and steel rule.
- Punch the marked line.
- Hold the workpiece firmly on the bench vice.
- Select the correct pitch blade (1.0mm pitch)
- Fix the blade in the hacksaw frame pointing teeth in the forward direction.
- Tighten the blade with required tension with the wing nut.
- File a notch at the point of cutting, to avoid slippage of the blade.
- Start cutting with a slight downward pressure.
- Release the pressure in the return stroke.
- Use full length of the blade.

Caution: In case the blade brakes in half the way, do not use a new blade. Finish the cut with a used blade.

Don’t tilt the frame while sawing.

TASK 2: Hacksawing on ‘T’ section
- Mark and hold the job in a bench vice.
- Punch witness marks
- File ‘V’ notch at the point of cutting to avoid slippage of blade
- Fix 1.4mm pitch hacksaw blade in hacksaw frame
- Start cutting with a slight downward pressure on ‘T’ section using hacksaw.
- Cut along the marked lines and separate the cutting portions.
- Cutting movement should be steady while sawing on ‘T’ section.
- While finishing a cut, slow down the pressure to avoid breakage of the blade and injury to you and others.
- Check the sizes of the cutting portions of the ‘T’ section with steel rule.

TASK 3: Hacksawing on flat section
- Check all the raw material size.
- File and finish raw material to size of 70x45x9mm.
- Apply lamp chalk and mark the profile as per drawing
- Punch witness marks on marked lines.
- Hold the job in bench vice
- File ‘V’ notch at the point of cutting to avoid slippage of the blade using triangular file.
- Fix 1.4 mm pitch flexible hacksaw blade in hacksaw frame.
- Start cutting with a slight downward pressure on metal using hack saw.
- Cut along the curved lines and separate the cutting portions
- Check the sizes of the cutting portions with steel rule.
Skill Sequence

Filing radius (external)

**Objective:** This shall help you to
- file external radius.

Filing radius is entirely a different technique, and needs considerable skill for filing accurately with a good finish.

In this type of filing, the file has to be held perfectly horizontal widthwise, and at the same time a rocking motion given lengthwise. The surface filed should not have any flat surface and should have a uniform curve. Radius filing of external surfaces is carried out in different steps.

**Rough filing of corners**
The corners are filed and brought closely to line using a flat bastard file. (Fig.1)

**Rounding of corners**
The flat surfaces are rounded and brought near about to finishing size, using a flat second cut file. In this, the file is moved forward across the curve with a turning motion. (Fig.2)

Check periodically with a radius gauge

**Final finishing of radius**
For finishing steps, a smooth file is used. The file is given a see-saw motion along the curved line until the required radius is formed. (Fig.3)

While filing make sure:
- to check the radius frequently with a radius gauge.
- to use the broad surface to the job as datum for checking the size.
- not to give excessive pressure while filing radius as the file is likely to slip.
Checking the radius

Objective: This shall help you to
• check the radius with a radius gauge.

Before checking with a radius gauge ensure the radius gauge is perfectly clean. Remove burrs, if any, from the workpiece. Check and make sure the profile of the gauge is not damaged.

The radius gauge should be held perpendicular to the radius to be checked. (Fig.1 and 2)

![Fig 1](image1)

File and adjust the radius gradually according to the radius gauge.

The right radius is the one that matches correctly with the gauge. (Fig.5)

After using the radius gauges, wipe them, clean with a clean cloth and apply a light film of oil before storing.

![Fig 2](image2)

Observe the contact surfaces for any light passing through, check against the background of light. The gauge should be moved along the filed length of the radius for checking. (Figs 3 and 4)

![Fig 3](image3)

![Fig 4](image4)

![Fig 5](image5)
Straight saw on thick section of M.S.angle and pipe

Objectives: At the end of this exercise you shall be able to
- mark and cut pieces on equal angle section.
- mark and cut pieces on pipe.
Job Sequence

TASK 1: Hacksawing on steel angle
- Check the raw material using steel rule.
- File the steel angle to size 100 mm length.
- Mark and punch the sawing lines.
- Hold the job in bench vice as shown in Fig 1.
- Fix 1.8 mm coarse pitch blade in hacksaw frame.
- Cut along the sawing lines with hacksaw.
- Check the size of the angles with steel rule.
- De-burr and preserve it for evaluation.

Caution
Select correct pitch blade according to the shape and material to be cut.
While sawing, two or more teeth of blade should be in contact on metal section.

TASK 2: Hacksawing on pipe
- Check the pipe size using steel rule.
- File the pipe ends to size 90 mm length.
- Mark and punch the sawing lines.
- Hold the job in bench vice as shown in Fig 1.
- Fix 1.0 mm pitch blade in hacksaw frame.
- Cut along the sawing lines using hacksaw.
- Turn and change the position of the pipe while hacksawing.
- Check the size of pipe using steel rule.
- De-burr and preserve it for evaluation.

Caution
Avoid over tightening the pipe in the vice which causes deformation.
Do not cut too fast.
Cut very slow and reduce pressure while cutting through.
File steps and finish with smooth file to accuracy of ±0.25mm

Objectives: At the end of this exercise you shall be able to
• mark steps with vernier height gauge
• cut metal by hacksawing
• file and finish steps to an accuracy of ± 0.25mm.
Job Sequence

- Check the raw metal with steel rule.
- File and finish the raw metal to size 45x45x18 mm.
- Mark the steps with vernier height gauge as per drawing and punch witness marks.
- Cut and separate the excess material by sawing fig 1

- File step with safe edge file using bastard, second cut and smooth grades.
- Measure the job sizes with outside micrometer maintaining the accuracy of ± 0.25 mm.
- Check the squareness with try square
- Similarly, cut and separate the excess material by sawing Fig 2

- File step with safe edge file using different grades
- Measure the job size with outside micrometer
- Check the squareness with try square
- Finish and de-burr the job
- Similarly, file and finish the another part 'B' and match with one another. Fig 3

- Apply thin coat of oil and preserve it for evaluation.
File and saw on M.S. square and pipe

Objectives: At the end of this exercise you shall be able to
• file, mark and saw in M.S.square as per drawing
• file, mark and saw in M.S.square hollow pipe as per dimensions.
Job Sequence

Task 1: Hacksawing on square section.

- Check the raw material size using steel rule.
- File and finish all sides of M.S. Square to 75x38x38mm and maintain parallelism and perpendicularity to each other.
- Mark and punch as per the drawing.
- Hold the job in bench vice, such that 35mm projecting outside jaw of bench vice.
- Cut along the marked line 1, 2 and 3 to the required depth Fig 1.
- Hold the job as shown in Fig. 2 to saw the other 3 pieces.
- Saw along the marked line and maintain perpendicularity and parallelism of the Job.

![Fig 1](image1)

![Fig 2](image2)

The cut piece should be parallel and should have uniform sawing mark.

Frequently wet the blade in soluble oil.

- Deburr the job and preserve it for evaluation.

Use coarse pitch blade for solid material and fine pitch blade for Hollow section.

Task 2: Hacksawing on square pipe.

- Check the raw metal size using steel rule.
- File and finish of M.S round pipe to φ 75 x φ 38 x φ 38 mm and maintain parallelism and perpendicularity to each other.
- Mark and punch as per drawing.
- Hold the job in bench vice and cut along the marked lines to the required depths as shown in job drawing.
- Check sawn metal with steel rule.
- De-burr the job and preserve it for evaluation.
File radius along a marked line (convex and concave) and match

Objectives: At the end of this exercise you shall be able to
• mark convex and concave radius
• file, convex and concave radius as per dimension
• match convex and concave radius as per drawing.
Job Sequence

Part 'A'

- Check the raw metal size using steel rule.
- File and finish to size 60x60x9 mm maintaining parallelism and perpendicularity.
- Mark and punch in part 'A' as shown in fig 1.

![Fig 1](image1)

- Mark line as shown in fig 2 leaving the metal 1 mm away from the object line.

![Fig 2](image2)

- Cut and remove, excess metal by sawing.
- Mark lines as shown in fig 3 and cut along the marked lines and remove excess metal.

![Fig 3](image3)

- File step 'A' to 15 mm with safe edge file and half round file using different grades and check the size with vernier caliper fig 4.
- Similarly, file step 'B' and check the size fig 4.
- File convex radius 'C' to 30 mm with half round file using different grades and check the radius profile with template.

![Fig 4](image4)

Instructor may arrange a template to check the radius.

Caution:
The flat surfaces are rounded and brought near about to finishing size, using a half round second cut file. In this, the file is moved across the curve with a rotary motion.
Check the radius frequently with a template.
Do not give excessive pressure while filing radius, as the file may likely to slip.

Part 'B'

- File and finish to size 45x45x9 mm maintaining parallelism and perpendicularity.
- Mark and punch the part 'B' as shown in fig 5.

![Fig 5](image5)

- Mark line as shown in fig 6 and cut along the marked line and remove excess metal.
- Mark line as shown in fig 7 and cut along the marked lines and remove excess metal.
- File concave radius with half round file using different grades and check the size with vernier caliper.
- Check the concave radius with template.
- Finish file and De-burr in part 'A' and 'B'.
- Match part 'A' and 'B' as shown in Job drawing.
- Apply a little oil and preserve it for evaluation.
Chip sheet metal (shearing)

Objectives: At the end of this exercise you shall be able to
• draw different types of geometrical shapes
• chip the different geometrical shapes by flat chisel.
Job Sequence

- Planish the sheet metal on a tinman's Anvil using mallet.
- Check the sizes of the sheet 150x150x0.5 mm using a steel rule.
- Mark the centre line as shown in job drawing.
- Punch the centre point using a prick punch 30° and a ball pein hammer.
- Mark a square of 150mm side using a steel rule, straight edge, 'L' square and scriber.
- Draw a circle of $\phi$120mm from the same centre point using steel rule and divider.
- Mark a hexagon of 50 mm side in the circle as shown in job drawing.
- Mark a pentagon of 40 mm side within the hexagon as shown in job drawing.
- Mark an equilateral triangle of 30 mm side within pentagon as shown in job drawing.
- Place the sheet on Anvil.
- Cut the square 150 mm side using flat chisel and ball pein hammer fig 1.
- Similarly, cut the other geometrical profiles. Circle (Fig.2) hexagon (Fig.3) pentagon (Fig.4) and triangle (Fig.5) using flat chisel and ball pein hammer.
- Check the different geometrical profiles with steel rule.
Chip step and file

Objectives: At the end of this exercise you shall be able to
• mark and chip as per drawing
• file step to the given dimension.

Instructor should assign the work to trainees.

• Write the job sequence to do the work
• List out the tools and equipments required
• Mark and cut the profile using chisel and file the profile to an accuracy of ± 0.5 mm

<table>
<thead>
<tr>
<th>1</th>
<th>ISSH 125 x 125 x 0.5</th>
<th>*</th>
<th>STEEL SHEET</th>
<th>*</th>
<th>*</th>
<th>1.2.37</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO.OFF</td>
<td>STOCK SIZE</td>
<td>SEMI-PRODUCT</td>
<td>MATERIAL</td>
<td>PROJECT NO.</td>
<td>PART NO.</td>
<td>EX NO.</td>
</tr>
<tr>
<td>SCALE 1:1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TITLE: PROFILE MARKING AND CUTTING

CODE NO. FIN1237E1
Mark off and drill through holes

Objectives: At the end of this exercise you shall be able to
• mark off using scribing block
• drill through holes using pillar/bench drilling machine.

NOTE: USE EX.NO: 1.2.31 TASK 1
Job Sequence

- Check the raw material for its size.
- Apply marking media.
- Mark as per the drawing dimensions and punch the centre of holes with centre punch.
- Periphery of the big holes should be punched with prick punch 60°.
- Fix the job on the machine vice.
- Fix Ø 4mm drill in drill chuck
- Set the spindle speed for Ø 4 mm drill.
- Ø 4mm drill can be used as a pilot for all the holes.
- Fix Ø 8, Ø 10 and Ø 16 mm drill one by one and drill through holes as per job drawing.
- Use coolant while drilling

**Caution: Use chuck key for tightening the drill in the drill chuck.**

- Use drift to remove the taper shank drill from drilling machine spindle. (Fig 1)
- Do not hammer on drift to remove it out.

Skill Sequence

Drilling through holes

**Objective:** This shall help you to
- drill holes of different diameter in a drilling machine.

Punch the centre of the hole to be drilled by a centre punch.

Set the job in the machine vice securely by using two parallel bars to clear the drill (Fig 1)
Fix the drill chuck into the spindle of the drilling machine.
Fix the 4 mm dia drill in the drill chuck for pilot hole.
Select the spindle speed by shifting the belt in the appropriate cone pulleys.
Drill all the holes first by 4mm drill. This will serve as a pilot hole for 8 mm, 10 mm and 16 mm dia drills.
Drill Ø 8 mm.
Drill Ø 10 mm hole.
Remove the drill and drill chuck.

| Caution: Do not remove chips with your bare hands- use brush. |
| Do not try to change the belt while the machine is running. |

Ensure that the drill do not penetrate into the vice.
Fix securely the drill deep into the drill chuck. (Fig 2)

Since the web of large diameter drills are thicker, the dead centres of those drills do not sit in the centre punch marks. This can result in the shifting of the hole location. Thick dead centres can not penetrate into the material easily and will impose severe strain on the drill.

These problems can be overcome by drilling pilot holes initially. (Fig 3)
Drill and tap on M.S.flat

Objectives: At the end of this exercise you shall be able to
• mark the tap holes with vernier height gauge
• determine the tap drill size
• drill tap drill hole on the job and chamfer it
• cut internal thread by hand tapping.

DRILLING AND TAPPING
Job Sequence

- Check the raw metal and file to size 75x50x9 mm.
- Mark the hole centres for the tap drill holes with vernier height gauge.

Drilling

- Set the pillar drilling machine for drilling operation
- Set the job on the machine vice.
- Fix the centre drill in a drill chuck.
- Align centre drill in drawing machine and drill in all hole location.
- Fix Ø 5 mm drill in a drill chuck and drill all the centre drilled holes. (this sewes as pilot hole for larger diameter drills).
- Drill two holes Ø 6.8 mm for M 8 tap.
- Drill two holes Ø 8.5 mm for M 10 tap.
- Drill Ø 14 mm at the centre of the work for M16 tap.
- Fix the counter sink tool in a drilling machine and chamfer all the tap drill holes both sides to 1.0 mm depth.

Tapping

- Fix the Job in bench vice.
- Cut M6 internal thread using M6 hand tap and tap wrench.
- Similarly, cut internal threads using M8, M10 and M16 hand tap and tap wrench
- Finish and De - burr all the surfaces of the Job.
- Clean all the threads without burrs.
- Apply a little oil and preserve the job for evaluation

Locating hole accurately by drilling centre drill

Objective: This shall help you to
- drill centre holes with a drilling machine.

Drilling centre holes by combination drills is an accurate method of locating the position of the holes (i.e. within ± 0.025mm). In drilling operations, this method will be specially helpful while drilling deeper holes, and holes of fairly accurate locations. For doing centre drilling, proceed as follows.

Hold the combination centre drill in the drill chuck and check whether it ‘runs true’. Adjust the spindle speed to suit the combination drill.

Adjust the job together with the vice and align with the centre punch mark. (Fig.1)

Drill a centre hole up to the depth of 3/4th of the counter sink. Do not apply undue pressure on the centre drill.

Apply sufficient quantity of cutting fluid.

Remove the centre drill. Drill hole with the required diameter twist drill. Check if it ‘runs true’. Start drilling the through hole.

Tapping through holes

Objective: This shall help you to
- cut internal threads using hand taps.

Determine the tap drill size either using the formula or the table.

Drill the hole to the required tap drill size. [An undersized hole will lead to breakage of the tap].

Chamfer the end of the drilled hole for easy aligning and starting of the tap. (Fig 1)
Fix the first tap (taper tap) in the correct size tap wrench.
Too small a wrench will need a greater force to turn the tap.
Very large and heavy wrenches will not give the ‘feel’
required to turn the tap as it cuts and may lead to breakage
of the tap.

Position the tap in the chamfered hole vertically by ensur-
ing the wrench is in a horizontal plane.

Exert steady downward pressure and turn the tap wrench
slowly in the clockwise direction to start the thread. Hold
the tap wrench close to the centre. (Fig 3)

Remove the wrench from the tap when you are sure of
starting the thread without disturbing the setting.

Check and make sure that the tap is vertical by using a try
square in two positions at 90° to each other. (Figs 4 & 5)

Make correction if necessary by exerting slightly more
pressure on the opposite side of the tap inclination.

Check the tap alignment again. The tap alignment should
be corrected within the first few turns. If it is tried afterwards
there is a chance of breaking of the tap.

Turn the wrench lightly by holding at the ends without
exerting any downward pressure after the tap is positioned
vertically. The wrench pressure exerted by the hands
should be well balanced. Any extra pressure on one side
will spoil the tap alignment and can also cause breakage
of the tap. (Fig 6).

Continue cutting the thread. Turn backwards frequently
about quarter turn, to break the chips. (Fig 7)

Stop and turn backwards when any obstruction to the
movements is felt.

Use a cutting fluid while cutting the thread to
minimise friction and heat.
Cut the thread until the hole is totally threaded. Finish and clean up using the intermediate and plug tap. The intermediate and plug tap will not cut any thread if the first tap has entered the hole fully. Remove the chips from the work and clean the tap with a brush.

Make sure that the dia of the hole to be tapped is correct for the given size of the tap. Turn backwards to break the chip after every quarter turn. Select the length of wrench suitable to the size of the tap. Overlength of wrench may cause the breakage of tap.
Objective: At the end of this exercise you shall be able to
• punch the letters and numbers.

Job Sequence

• Check the raw material size.
• Mark the line to punch the letters.
• Measure the length.
• Select the size of the letters according to space
• Count the letters on each line.
• Position the letter punch and hold vertical position hammer vertically above the punch.
• Practice letter and number punching.
Skill Sequence

Objective: This shall help you to
• punch letters and numbers.

Letter and number punches
These hardened and tempered steel punches are used to stamp identifying symbols, letters or numbers as required on the work.

They are obtainable with symbols ranging in size from 0.8 mm to 13 mm.

They are kept in boxed sets.

Use a file on the work to be stamped to check the work is softer than the punch. Any attempt to stamp hard material would damage the punch. Use an electric pencil or acid etching to mark hard materials. (Fig 1)

Each symbol must be made with a single blow. A second blow gives a distorted second impression.

Letters such as M and W may require firmer blows to produce the same depth of impression such as letters I and T can make.

The depth of impression for a given blow varies with the softness of the material.

Practice on different metals.

Use the punches in the following manner:
- Mark out the guidelines for the symbols.
- Check that you have the correct symbol.
- Position the punch so that the symbol will be in line, square, correctly spaced and the correct way up. (Fig 2)

Hold the punch in a vertical position. (Fig 3)

Hold the hammer vertically above the punch. (Fig 3)

Watch the point of the punch.

Strike the punch squarely with one firm blow.
Practice use of different punches

Objectives: At the end of this exercise you shall be able to
• mark and punch holes on gasket with hollow punch
• dismantle taper pin/dowel pin in an assembly.

TASK 1

TASK 2

<table>
<thead>
<tr>
<th>1</th>
<th>GASKET</th>
<th>100 x 70 x 3.0mm</th>
<th>*</th>
<th>RUBBER</th>
<th>*</th>
<th>*</th>
<th>1.2.41</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO.OFF</td>
<td>STOCK SIZE</td>
<td>SEMI-PRODUCT</td>
<td>MATERIAL</td>
<td>PROJECT NO.</td>
<td>PART NO.</td>
<td>EX. NO.</td>
<td></td>
</tr>
<tr>
<td>SCALE 1:1</td>
<td>PRACTICE WITH HOLLOW AND PIN PUNCH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TOLERANCE: NIL  TIME: 9Hrs

CODE NO. FIN1241E1
Job Sequence

TASK 1: Mark and punch holes on gasket
- Mark as per drawing in Gasket.
- Locate the intersection of the hole point using pencil.
- Draw Ø 8 mm hole circles with divider.
- Punch and make a hole with Ø 8 mm hollow punch - Fig 1.

For TASK 1 provisions may be made for Gasket/Leatheroid sheet/Rubber or cork sheet for the practice.

TASK 2: Taper dowel pin dismantle
- Select a suitable pin punch according to the dismantling of taper pin fig 1.

For TASK 2 provisions may be made for disassemble the fixtures of jigs where the dowel pins are provided for practice or removal of dowels.

- Always use starter drift punch first to dismantle the taper pin in machine assembly.
- Use pin punch (short) or (long) also to dismantle the taper pin in assembly.
- While dismantling the dowel taper pin, strike with hammer on dowel pin with light blow.
### Exercise 1.3.42

**Marking of straight lines, circles, profiles and various geometrical shapes and cutting the sheets with snips**

**Objectives:** At the end of this exercise you shall be able to
- flatten a sheet using wooden mallet
- mark parallel lines, curved lines, circles and geometrical shapes
- cut sheet metal on straight lines using straight snips
- cut sheet metal on curved lines using curved snips
- cut sheet metal on various geometrical shapes.

#### Task 1

![Diagram of sheet metal dimensions](image)

**MARKING AND CUTTING ON STRAIGHT LINES**

<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>
<th>CODE NO.</th>
<th>TIME 15h</th>
<th>DEVIATIONS ±1.00mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ISSH 105 x 105 x 1.00mm</td>
<td>-</td>
<td>G.I. SHEET</td>
<td>-</td>
<td>TASK 6</td>
<td></td>
<td>FIN1342E1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>ISSH 75 x 75 x 1.00mm</td>
<td>-</td>
<td>G.I. SHEET</td>
<td>-</td>
<td>TASK 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>ISSH 75 x 75 x 1.00mm</td>
<td>-</td>
<td>G.I. SHEET</td>
<td>-</td>
<td>TASK 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>ISSH 125 x 125 x 1.00mm</td>
<td>-</td>
<td>G.I. SHEET</td>
<td>-</td>
<td>TASK 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>ISSH 105 x 105 x 1.00mm</td>
<td>-</td>
<td>G.I. SHEET</td>
<td>-</td>
<td>TASK 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>ISSH 155 x 80 x 1.00mm</td>
<td>-</td>
<td>G.I. SHEET</td>
<td>-</td>
<td>TASK 1</td>
<td>1.342</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TASK 2

MARKING AND CUTTING ON CIRCLES

100

50

120

MARKING AND CUTTING ON CURVED LINES

100

120

MARKING AND CUTTING VARIOUS GEOMETRICAL SHAPES IN G.I. SHEET

CODE NO. FIN1342E2

114 Capital Goods & Manufacturing - Fitter : Exercise 1.3.42
Task 4

MARKING AND CUTTING TRIANGLE

Task 5

MARKING AND CUTTING SQUARE

Task 6

MARKING AND CUTTING HEXAGON

115
Job Sequence

TASK 1: Marking and cutting on straight lines
Check the size of the sheet steel as per sketch using a steel rule.
Level the sheet on the workbench or a bench stake using a mallet.
Mark a rectangle on the sheet metal as per sketch using 'L' square, steel rule and scribe.
Set the steel rule on the outline of the sheet for 25mm.
Mark off two 'V' marks at 25mm from each long side.
Scribe a line through the 'V' marks, throughout the length of 150mm.
Similarly, mark other lines 20mm, 15mm, 10mm and 5mm apart from each other.
Hold the sheet by left hand.
Cut the sheet by the right hand on the line, using straight snips.

TASK 2: Marking and cutting on circles
Check the size of the square sheet as per sketch, using a steel rule.
Level the sheet on a levelling plate using a mallet.
Mark a square on sheet metal as per sketch.
Mark and punch the centre of the square sheet.
Draw 12mm concentric circle at the centre of square.
Similarly, scribe other 7 concentric circles with equi distant radius.
Cut the circle lines using bend snips.

TASK 3: Marking and cutting on curved lines
Flatten the sheet metal using a wooden mallet and a tinman's anvil stake.
Check the size of the sheet using a steel rule.
Mark square 100 x 100 using a steel rule, a straight edge and a 'L' square.
Mark the centre line as shown in Fig.1
Cut along the marked outside curved lines 1 to 4 using straight snips. (Fig.2)
Cut along the marked inside curved lines 5 to 9 using bend snips. (Fig.2)
Check the dimensions of the cut pieces using a steel rule.
Flatten the sheet on anvil stake with wooden mallet.
Check surface flatness with edge of steel rule.

Mark point 'A' and punch using a dot punch and a ball pein hammer.
Taking point 'A' as the centre, mark curved line radius 10mm using a wing compass.
Similarly, mark other curved lines as per job drawing.
Check the marked curved lines using a steel rule.
TASK 4: **Marking and cutting triangle**
Check the size of the sheet as per sketch using a steel rule.
Level the sheet on the bench stake using a mallet.
Punch the centre of the sheet by a prick punch.
Draw a $\varnothing 65$mm circle using a divider on the sheet.
Punch a dot on the circumference of the circle by a prick punch.
Mark three arcs equal to the side of the equilateral triangle and join the arcs by lines.
Cut along the marked lines using straight snips.
Check the triangle size with steel rule.

---

**TASK 5: Marking and cutting square**
Check the size of sheet as per sketch using a steel rule.
Mark the centre lines.
Punch the centre of the sheet by a prick punch.
Draw a $\varnothing 60$mm circle using divider on the sheet at point 'O'.
Join points A,B,C,D and inscribe the square.
Cut along the marked lines using straight snips.

---

**TASK 6: Marking and cutting hexagon**
Check the size of the sheet as per sketch using a steel rule.
Level the sheet on a levelling plate.
Mark centre lines.
Punch at the centre of the sheet 'o'.
Draw $\varnothing 90$mm circle.
Scribe arcs on the circumference, each arc being equal to the radius of the circle.
Join points A,B,C,D,E & F and construct the hexagon.
Cut along the marked lines using straight snips.
Skill Sequence

Flattening the sheet metal

Objective: This shall help you to
• flatten the sheet metal of various sizes.

Clean the tinman’s anvil stake and the job.
Place the job on the anvil stake top. (Fig 1)

If the size of the sheet metal is smaller than the face of the stake, place the sheet somewhere in the middle of the stakeface. (Fig 2)

Check the flatness of the sheet metal with the edge of the steel rule. While checking the flatness, place the edge of the steel rule on the surface of the sheet and observe the gap between the steel rule edge and the surface of the sheet metal. (Fig 4)

If a gap is not observed, then the sheet is perfectly flat.
If a gap is observed, then the sheet is not flat at the points of the gap.
Flatten the surface at the points of the gap if a gap is observed.

Measuring and marking the sheet metal

Objectives: This shall help you to
• measure the linear dimensions of the sheet metal using a steel rule
• mark parallel lines using a steel rule, a straight edge and a scriber.

Measuring

– Clean the edges of the steel rule using a waste cloth.
– Place the graduated edge of the steel rule on the workpiece such that the edge is perpendicular to the lines or the edges. (Fig 1)

– Coincide one line with a large graduated line (Centimeter lines) on the steel rule.
– Taking this as a reference dimension, note the dimension on the scale coinciding with the line/edge between which the distance is to be checked.
Determine the distance between the two lines. For example, if 50 mm is the reference dimension and 100 mm is the dimension coinciding with the line between which the distance is to be checked, then 100-50 = 50 mm is the distance between the two lines.

Mark a straight line on the sheet: Mark off two 'V' marks from the datum 'xx' at a distance as required for measurement, using a steel rule and a scriber. Datum 'xx' is at right angle to datum 'yy'. (Fig 2)

Set the straight edge in between the 'V' marks and press the straight edge with your fingers. (Fig 3)

While scribing lines, hold the scriber close to the straight edge as shown in Fig 4.

Incline the scriber at an angle of 45° approximately as shown in Fig 5 and scribe a line towards you along the edge of the straight edge.

If the inclination is opposite from you, it will cause damage to the sheet and will remove the top layer of the metal. Don't apply excessive pressure while scribing lines using the scriber to avoid the removal of the metal. Fig 6.

The line AB is the parallel line to the datum xx. (Fig 7)

For economical marking

To avoid wastage, always scribe lines from left hand bottom corner as shown in Fig 8 but not as in Fig 9.
Marking with wing compass

Objectives: This shall help you to
• set the required dimension on a wing compass
• draw circles and arcs with a wing compass.

Wing compass
Verify that the legs of the compass are of the same length. (Fig 1)

If not, grind the leg and sharpen with an oilstone.

Punch at the intersection of the marked lines. (Fig 2)

Draw parallel lines as in Fig 10 as per the dimensions shown in Job drawing. (Ref. Job sequence for Ex.No.1.3.42 Task 1.)

While adjusting the compass opening, use the middle of the rule and not the edge.

For larger lengths, place the rule on the worktable and adjust the compass opening, with both tips on the rule.

To close the legs fractionally, tap the outside of the leg lightly.

To open them fractionally, turn the compass upside down and tap the head lightly. (Fig 4)

After setting the dimensions, lock the legs with the wing nut and check the dimensions again.

Hold the compass head with the palm of your hand to prevent the compass point from slipping from the centre of the circle.

Do not press the wing nut.

Draw an upper half circle from the lower left to the right, using thumb pressure. (Fig 5)

Change the thumb position on the compass, and draw the rest of the circle from the lower left. (Fig 6)

For small lengths, loosen the wing nut and open the compass wider and then squeeze with your right hand to adjust and match the required length on the rule. (Fig 3)
When drawing, tilt the compass slightly in the direction of rotation.

**Draw clearly the first time itself.**

**Mark curved lines**

**Objectives:** This shall help you to
- mark the centre line using a scriber and a steel rule
- punch a dot mark using a dot punch
- mark curved lines using a wing compass.

Clean the tinman’s stake and the sheet metal surface.

Flatten the sheet metal using a wooden mallet.

Check the size of the sheet metal using a steel rule.

Mark ‘V’ at the centre of the workpiece on opposite sides and join it using a steel rule and a scriber. (Fig 1)

Mark the centre point on the centre line.

To punch the centre point use a dot punch. Place the sheet on the anvil stake. Hold the punch between the thumb and the first two fingers of the hand where possible, rest the little finger and the edge of your hand on the marked centre point as shown in Fig 2.
Bring up the dot punch in the vertical position and strike with a ball pein hammer on the head of the dot punch lightly. Watch the point of the punch and strike its head with the ball pein hammer Fig 3. This dot punch marks prevent the wing compass leg from slipping while scribing curved lines from the centre point.

Only a small dot is needed to prevent the wing compass from slipping. If the dot is too big, compass leg will wander as shown in Fig 4.

Now set the wing compass to the required dimension. Set one leg of the wing compass at the centre point, and scribe a curved line (arc) by rotating the wing compass as shown in Fig 5.

Safety: While striking the head of the dot punch, the hammer face must be free of burrs and oil substances. The hammer head must be held tight on to the handle by wedge.

Cutting the sheet metal along straight line by straight snips

Objectives: This shall help you to
• cut the sheet metal along a straight line by straight snips.

Hold the sheet in one hand and snip with the other hand, hold the snips handle at the end and place the upper blade of the snips on the line by keeping a smaller opening angle. (Fig.1)

Grip the snips so that both the blades are engaged with each other without any clearance between the blades. Maintain the gap in between the blades, to less than 20° (Fig 2&3)
Keep the blade perpendicular to the surface of the sheet metal and hold the snips straight. (Fig 4)

Do not use the full length of the blade for a single stroke.
If you use the full length of the blade for a single stroke, the cutting line will not be straight and also the blade corner will damage the sheet. (Fig.5)

As far as possible, keep a small part of the sheet on the left hand side at the time of cutting the sheet. (Fig.6)

If stops are not provided in snips, care should be taken while cutting the sheet, not to pinch the palm of the hand between the bent ends of the snip handles while closing. (Fig.7)

Cut the material along the scribed lines. (Fig.8)
Cutting along curved lines

Objectives: This shall help you to
• cut outside curves on sheet metal by straight snips
• cut inside curves on sheet metal by bend snips.

Cutting outside curves by straight snips
Hold the workpiece in one hand.
Hold the straight snips by the other hand at the handle end.
Keep the straight snips blade on the outside curved line at 90° angle and gently press the handle. This produces the shearing force which cuts the material. (Fig 1)

Accordingly, continue the process along the total length of the curved line, point by point, till the curved line ends.

Use small length of blade, while cutting outside curved lines to get correct curved shape.

Cutting inside curves by bend snips: The skill sequence is similar to that of cutting external curves except bend snips are used for cutting along internal curved lines. (Fig 2)

Sharpening of snips

Objective: This shall help you to
• sharpen the blunt snips.

Introduction: After continuous use, the cutting edge of the snips gets worn out and requires resharpening. (Fig.1)

Ways of sharpening snips
1 Sharpening by files
2 Sharpening by oilstone
3 Sharpening by grinding wheel

Sharpening by files: Clamp the handle of the blade to be sharpened as shown in Fig 2.
Remove the snips from the vice, clamp the other handle in the vice as done before.

Sharpen the second blade by file.

**Sharpening by oilstone:** Clamp one handle of the snips in a benchvice.

Use the oil stone the same way as you use a file. (Fig 4)

Use the coarse side of the oil stone first. Use the fine side of the oil stone for finishing.

Remove the snips from the vice and repeat the same for the other blade.

**Sharpening by grinding wheel**

Switch on the off hand grinder.

Open the blades of the snips as far as possible.

Lay each blade to the grinding wheel as shown in Fig 5. Start grinding from the pivot joint and draw the blade across the grinding wheel. (Fig 6)

---

**Marking triangle in a given circle**

**Objective:** This shall help you to

- **draw a triangle inside a given circle.**

Draw the diameter BD of the circle. (Fig 1)

Draw an arc d/2 as radius and D as centre.

Let this arc intersect the circle at A and C. (Fig 2)

Join AB, BC, and AC to each other.

ABC is the triangle drawn inside the given circle. (Fig 3)
Marking square in a given circle

Objective: This shall help you to
• inscribe a square in a given circle.

Draw the diameter AC of the circle. (Fig 1)

Bisect AC. (Fig 2)

Draw two arcs 1 and 2 with A and C as centres on the top and bottom of the line AC. (Fig 3)

Let the arcs meet at B and D.

Join the points B and D

BD is the bisector of AC.

Join AB, BC, CD and DA to each other.

ABCD is the square drawn inside the given circle. (Fig 3)
Marking a regular hexagon

Objective: This shall help you to
- inscribe a regular hexagon in a circle.

Inscribe a regular hexagon in a circle. (Fig 1)

Draw the diameter vertically to the given circle whose centre is 'O'.
Let A and B be the intersecting points on the circumference. (Fig 2)

With AO as radius and A and B as centre, draw two arcs CD and EF respectively with the help of a compass. Let C,D,E,F be the intersecting points on the circumference. (Fig 3)

Connect points A,D,F,B,E and 'C' to each other. (Fig 4)
Now a regular hexagon is inscribed in the circle.
Marking out of simple development

Objectives: At the end of this exercise you shall be able to
- prepare development of cylinder in parallel line method
- prepare development of rectangular tray in parallel line method
- mark out the flaps for hemming.

TASK 1

HEMMING
5mm

LOCKED GROOVED JOINT
5mm

PARALLEL LINE DEVELOPMENT OF CYLINDER

CODE NO. FIN1343E1
TASK 2

PARALLEL LINE DEVELOPMENT OF RECTANGULAR TRAY

Capital Goods & Manufacturing - Fitter : Exercise 1.3.43
**Job Sequence**

**TASK 1:** Parallel line development of cylinder

Develop and layout the pattern for the cylinder with all allowance for joining and hemming on drawing sheet by parallel line method.

Draw the elevation and plan of the object as per the given dimensions on drawing sheet (A3)

Divide the periphery of the circle into 12 equal parts. (Fig.1)

![Fig 1](image1)

Extend the line from the base to the maximum length, i.e more than the circumference of the cylinder. (Fig.2)

![Fig 2](image2)

Draw line parallel to base line to the height of 124mm (Height of cylinder) and draw perpendicular line at the end of 314mm base line.

Transfer the distance from 0 to 1, using a compass on the base line as per shown in Fig.2 and continue to mark 1 to 2, 2 to 3 upto 11 to 12.

**TASK 2:** Parallel line development of rectangular tray

Calculate developed length and width of a rectangular box.

Developed length = Base length + 2(side height + single term allowance)

= 80 + 2(20 + 5) = 130mm

Developed width = Base width + 2(side height + single term allowance)

= 35 + 2(20 + 5) = 85mm

Mark and cut the sheet metal work piece to the size of 130x85mm maintaining squareness.

Draw the centre lines of the length and width XX and YY. (Fig.1)

![Fig 1](image3)
Draw the base length and width at the centre of the work piece from centre line. Mark lines at 40mm on both sides of YY and 17.5mm on both sides of XX (Fig.2).

Draw lines for 20mm height of the four sides of the rectangular box parallel to AB, BC, CD and DA as shown in the Fig.3.

Draw lines for 5mm single hemming allowance on the four sides parallel to FG, HI, JK and LE as shown in Fig.4.

Draw lines on 20mm lap for the solder joint at the corners of the rectangular box parallel to GB, AF, CJ and DK as shown in Fig.5.

Draw lines for 45° slant notches at points H, I, J, K, L, E, F, G, A, B, C and D as shown in the Fig.6.

Complete the development of rectangular tray as per the given dimension.
**Skill Sequence**

**Parallel line development of a cylinder**

**Objectives:** This shall help you to
- develop and layout a pattern for a cylinder by parallel line development method.

Draw the front elevation and the plan of the cylinder on a paper. (Fig 1)

Divide the periphery of the circle into 12 equal parts and check each division. (Fig 2)

Extend the lines to a length slightly more than the circumference of the circle (pd) plus the allowances for the locked grooved joint. (Fig 3)

Draw a line 00' perpendicular to the parallel line through the left end. (Fig 4)

Transfer equal distances 0, 1, 2, 3, 4 upto 12 of the plan on the circumferential line without disturbing the equal lengths with compass. (Fig 5)

Draw a perpendicular at the end of the twelfth point of layout to the base line. (Fig 6)

Draw parallel lines to line 00' at points 1, 2, 3, 4 upto 12. (Fig 6)

Mark the lines at 4 mm distance on the top and bottom of the pattern for hemming at the top edge and joining at the bottom edge. (Fig 7)

Draw the lines parallel to 00' and 12 12' at a distance of 5 mm and 10 mm on both sides respectively for seaming. (Fig 7)

Now the pattern is completed.

Scan the QR code to view the video for this exercise
Marking out for flaps for soldering and sweating

Objectives: At the end of this exercise you shall be able to
• make rectangular tray as per given dimensions
• develop the pattern by parallel line method
• cut as per the required dimensions and make the rectangular tray
• solder and sweat soldering.

TASK 1

NOTE: USE EX.NO: 1.3.43 TASK-2 G.I SHEET FOR EX.NO: 1.3.44 TASK-1

SCALE 1:1

MAKING RECTANGULAR TRAY AND FLAPS SOLDRING

DEVIATIONS ±1mm TIME: 3Hr

CODE NO. FIN/344E1
### Task 2

#### Soldering / Sweating

<table>
<thead>
<tr>
<th>No.</th>
<th>Stock Size</th>
<th>Semi-Product</th>
<th>Material</th>
<th>Project No.</th>
<th>Part No.</th>
<th>Ex. No.</th>
<th>Task 2</th>
<th>1.3.44</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ISSH 75 x 50 x 1.0mm</td>
<td>--</td>
<td>G.I. Sheet</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

**Scale 1:1**

**Soldering and Sweating**

**Deviations ±1mm**

**Time: 2hr**

**Code No.** FIN1344E1
Job Sequence

TASK 1: Making rectangular tray and flaps soldering
Check the size of sheet as per sketch using a steel rule.
Level the sheet on the levelling plate using a mallet.
Develop the tray by the parallel line method.
Cut the unwanted area shown in shadow using a straight snip (Fig.1)
Cut the notches at 45° using a straight snips (Fig.1)

Deburr the edges of the sheet metal pattern using a smooth flat file.
Form a single hemming on four sides of the tray.
Bend the four sides to 90° using a Tinman’s anvil.
Bend all the flaps to 90°. (Fig.2)
Join the four corners by soft soldering.

TASK 2: Soldering and sweating
Cut two pieces to the size 75 x 50mm.
Flatten the sheets on Tinman’s anvil.
Clean the surfaces to be joined thoroughly with abrasive cloth and a dry cloth.
Apply flux on surface of the sheets.
Place the surfaces to be joined in correct alignment as shown in Fig 3.
Heat the soldering iron bit in forge or blow lamp, hot enough to melt the solder.

Dip the point of the soldering bit into a dipping solution to avoid oxidation.
Apply solder to the bit.
Place the bit in correct position, over the lap opening at one end of the joint.
Lift the bit from the joint to get a smooth tack of solder.
Similarly tack at regular intervals along the joint.

Tacking provides temporary holding of the sheets.

Move the bit steadily along the joint in one direction.
Continue the soldering until the joint is completed.
Similarly, solder other side of the lap joint following above procedures.
Allow the joint to cool.
Wash off all traces of flux with running water.
Clean the job with rag.
Skill Sequence

Preparing the soft solders

Objective: This shall help you to
• prepare soft solder in varying proportion in the form of stock to suit the metal to be joined.

In soft soldering process, soft solder is required to be prepared in the required proportion of tin and lead, when tin and lead are supplied in pure form.

They are generally prepared in the form of triangular sticks.

First measure required quantities of tin and lead in kilograms. For example to prepare 60/40 soft solder, take 600 gms of tin and 400 gms of lead to prepare 1 kg of soft solder.

Melt the lead first in a crucible, cast iron pan or ladle. (Fig.1) Lead is melted first because its melting temperature is higher than tin. (327°C)

Add little amount of sulphur to the mixture as flux and clean the alloy. (5 gm of sulphur/kg of solder)

Restirr the mixture and increase the temperature until the alloy is free flowing.

Sulphur unites with impurities which rise to the surface, burns and forms a dross.

Remove the dross with a perforated ladle. (Fig 2)

Use angle iron as a mould.

Clean the angle iron and pour the molten solder carefully and continuously as shown in Fig 3.

WARNING
Molten solder will splatter violently in contact with moisture. The moulds must be preheated.

Allow the solder to set.

Remove the stick after getting cooled.

Add tin slowly to the molten lead and blend by stirring the mixture. (Fig 1)

Reduce the temperature of solder until the mixture will not flow readily.
Preparing the working point of soldering bit

Objective: This shall help you to
• tin a soldering bit for free and uniform flow of solder on to the workpiece without oxidation.

In case of a new bit, hold the bit in a vice and file the burrs from the face and edges and lightly round off the point with a file.

In case of a bit in use, clean the bit point with a file, remove the pitted faces and rough edges. (Fig.1)

If the soldering bit is too hard to file, heat it till it melts the solder freely and then cool it by dipping into cold water.

Heat the bit until colours appear on the faces, Don't overheat the bit.

Rub all faces on sal-ammoniac cake. (Fig 2)
Apply stick solder to each working face, as it is rubbed on the sal-ammoniac cake.
Spread the solder uniformly over the faces and remove the excess solder by wiping with a piece of rag. (Fig 3)
Now a thin bright film called “tin” is formed on the faces of the copper bit. This is called tinning.

Tacking and soldering the joint

Objective: This shall help you to
• set and tack the lap joint in correct alignment
• solder a lap joint with uniform flow of solder, in flat position
• inspect a lap joint, to ensure strong joint.

Check the size of the material using steel rule and trysquare. Select a suitable type of soldering bit. (Copper)
Tin the soldering bit. Select the suitable flux for the job.
Select the suitable solder for the job.
Clean the surface to be joined with an abrasive cloth and then with a dry cloth, making it free from dirt, rust, oil, grease etc. (Fig 1)
Apply flux to the joint as shown in Fig.2.
Place the surfaces to be joined in correct alignment.
Heat the bit in forge or blow lamp, hot enough to melt the solder readily. The effect of heating the bit is shown in Fig 3.

Avoid breathing fumes from the sal-ammoniac which causes headache and is injurious to the lungs.
Do not allow it to become red hot otherwise tinning gets burnt off or it will form a bronze coating over the tip, on which solder will not stick properly.

Dip the point of the bit into a dipping solution to avoid oxidation. (Fig 4)

Apply solder to the bit.

Place the bit in correct position, over the lap opening at one end of the joint. (Fig 5) Hold the bit steady till the solder flows onto the workpiece and covers the lap opening. (Fig.5)

Lift the bit from the joint to get a smooth tack of solder. (Fig 5)

Similarly, tack at regular intervals along the joint. Tacking provides temporary holding of the sheets. (Fig 6)

Re-heat the bit, if necessary. Place the bit on one end of the seam, add solder to the bit and allow the solder to melt and flow into the joint, which takes place by capillary action.

While soldering, to prevent the lap joint from springing apart, the joint is held in place by a stick of wood.

Move the bit steadily along the joint with a consistent movement, in one direction. (Fig 7)
Add solder as required.
Continue the soldering until the joint is completed.
The joint will not be satisfactory if the solder is just ‘struck on’ or ‘melted on’. Solder should flow freely. Allow the joint to cool.
Wash off all traces of flux with running water and clean the job with rag. (Fig 8)

Inspect the lap joint for the penetration of the solder into the lapped surfaces.
Ensure that the opening is sealed with a neat, smooth fillet of solder.
Upper surfaces of the seam should show a smooth, thin coatings of solder, uniform in width with tidy solder margins.

Never file the soldered joint.

Sweating or sweat soldering

Objective: This shall help you to
• sweat solder a lap joint, using a blow lamp.

Cut the sheet or pieces to the required size and mark.
Clean the surfaces to be joined thoroughly free of dust, dirt and oily surface.
Coat the surface to be joined with flux. (Fig 1)

Press down the joint with a rod, as the solder in between the two surfaces begins to melt and flow. (Fig 3)

Apply an uniform coating of solder to each of the surface to be joined. (Fig 2)

Draw the bit copper slowly along the joint and follow with the hold down piece.
While moving the copper bit forward, ensure that the solder melts. Otherwise, the joint will not be proper.
Constant supply of heat will produce a successful sweat soldered joint.
Hence, it is advisable to use two copper bits for this operation whereby, when one is in use, the other can be heated and kept ready for continuous operation.

Sweat soldering can also be done using a blow pipe as shown in Fig 4.

Place and align the tinned surfaces one on the top of the other.
Ensure that the tinned surfaces are in contact.
Place the flat side of the heated copper bit on one end of the joint.
Various sheet metal joints

Objectives: At the end of this exercise you shall be able to
• make a single hemming and double hemming joints
• make a paned down seam joint by using hand tools
• make a knocked up seam joint by using hand tools
• make a locked groove joint using hand grooves
• make a straight edge wired joint by hand process.
TASK 3

PANE DOWN SEAM JOINT

PART 1

90°

PART 2

65

50

TASK 4

KNOCKED UP SEAM JOINT (SINGLE SEAM)

PART 1

65

50

KNOCKED UP JOINT

PART 2

1 | ISSH 60 x 50 x 0.8 | - | GI SHEET | - | PART 1 | TASK 3
1 | ISSH 60 x 50 x 0.8 | - | GI SHEET | - | PART 2 | TASK 3
1 | ISSH 85 x 50 x 0.8 | - | GI SHEET | - | PART 1 | TASK 4
1 | ISSH 85 x 50 x 0.8 | - | GI SHEET | - | PART 2 | TASK 4

NO.OFF | STOCK SIZE | SEMI-PRODUCT | MATERIAL | PROJECT NO. | PART NO. | EX. NO. 1.3.45

SCALE 1:1

SHEET METAL JOINTS

DEVIATIONS: ±1mm
TIME 8Hrs

CODE NO. FIN1345E2

Capital Goods & Manufacturing - Fitter: Exercise 1.3.45
TASK 5

134

PART 1

PART 2

60

6-SEAM

LOCKED GROOVED JOINT

TASK 6

Ø3 G.I WIRE

80

200

MARKING A STRAIGHT EDGE WIRED JOINT (BY HAND PROCESS)

<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>
<th>TASK 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>ISSH 75 x 60 x 0.6</td>
<td>G.I SHEET</td>
<td></td>
<td>PART 1 &amp; 2</td>
<td>TASK 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Ø3 - 210</td>
<td>G.I WIRE</td>
<td></td>
<td></td>
<td>TASK 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>ISSH 215 x 95 x 0.8</td>
<td>G.I SHEET</td>
<td></td>
<td></td>
<td>TASK 6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SCALE 1:1

DEVIATIONS ±1mm  TIME 10Hrs

CODE NO. FIN1345E3

Capital Goods & Manufacturing - Fitter : Exercise 1.3.45
Single hemming and double hemming on curved edge.

TASK 7

SHEET METAL JOINTS
Job Sequence

TASK 1: Single hemming by hand process

- Mark and cut the sheet as per drawing (ISSH 100 x 62 x 0.6mm GI sheet)
- Flatten the sheet using a mallet on a dressing plate. (Fig.1)
- Mark two lines at a distance of 6mm from both edges for single hemming with folding clearance. (Fig.2)
- Fold one edge of the sheet using a hatchet stake and a mallet for single hemming. (Fig.3)
- Flatten the single hemmed edge of the job sheet metal on the dressing plate using a mallet. (Fig.4)
- Similarly, repeat the above process in another edge for single hemming.
- Check the flatness and the straightness of the single hemmed job of sheet metal.
- Examine the single hemming edges without gap.

TASK 2: Double hemming by hand process

- Mark and cut the sheet as per drawing. (ISSH 100x66x0.6mm G.I. sheet)
- Flatten the sheet using a mallet on a dressing plate.
- Remove burrs on edges of the sheet with flat smooth file.
- Mark two lines at a distance of 6mm from both edges for single hemming with folding clearance.
- Fold one edge of the sheet using a hatchet stake and a mallet for single hemming. (Fig.1)
- Flatten the single hemmed edge of the job sheet metal on the dressing plate using a mallet. (Fig.2)
Mark again, the two lines at a distance of 6mm from the single hem for double hemming. (Fig.3)

Fold the single hemmed edge of the job sheet metal using a hatchet stake and a mallet for double hemming. (Fig.4)

Flatten the double hemmed edge of the sheet metal on the dressing plate using a mallet (Figs 5 & 6)

**TASK 3: Paned down seam joint**

Mark and cut sheet to the size as per drawing
(Part I ISSH 60 x 50 x 0.6mm G.I. sheet)
(Part II ISSH 80x50x0.6mm G.I. sheet)

Flatten the sheets using a mallet on a dressing plate.

Remove burrs on edges of the sheet with flat smooth file.

Mark the setting down operation for the single seam (paned down joint) in part 1.

Fold edge of the sheet to 90° using a hatchet stake and a mallet for single hemming in part 1 (Fig.2)

Mark the setting down operation for the single seam in part 2 (paned down joint) (Fig.3)

Fold edge of the sheet using a hatchet stake and a mallet for single hemming in part 2 (Fig.4)
• Set the part 1 and 2 using try square as per shown in the sketch for single seam pane down joint. (Fig.5)

• Strike on the edge of the flange and complete, the operation for the pane down joint. (Figs 6 & 7)

• Examine the pane down joint, without gap.

TASK 4: **Knocked up seam joint (single seam)**

• Mark and cut sheet to the size as per drawing.
  (Part 1 ISSH 65x50x0.6 G.I SHEET)
  (Part 2 ISSH 85x50x0.6 G.I SHEET)

• Flatten the sheet using a mallet on a dressing plate.

• De-burr on edges of the sheet with flat smooth file.

• Mark the setting down operation for the single seam in part 1 (knocked up seam joint) (Fig.1)

• Fold to form the edge of the sheet using a hatchet stake and a mallet for single seam in part 1. (Fig.2)

• Form the edge of the sheet using a hatchet stake and a mallet for single seam in part 2. (Fig.4)

• Set the job part 1 and part 2 on a half moon stake and join bent leg with a mallet as shown in figure. (Fig.5)

• Mark the distance in part 2 for single seam (Fig.3)
• Support the job by hand and strike with the mallet all around to an angle as shown in figure to form knocked up joint. (Fig.6)

- Tighten the double seam (knocked up joint) using the planishing hammer as shown in figure. (Fig.8)

• Increase the angle of the bend gradually while striking with the mallet all around the seam as shown in figure to form knocked up joint. (Fig.7)

- Place the edge of the joint on the square stake and lightly dress the bottom with the planishing hammer as shown in figure and finish the knocked up joint. (Fig.9)

- Examine the knocked up joint.

**TASK 5: Locked grooved joint**

• Mark and cut the sheet into two pieces as per drawing Part 1 and Part 2 - ISSH 75x60x0.6 mm each one

- Flatten the sheet metal.

- De-burr on edges of the sheet.

- Determine the fold size of the given seam.

- Mark the straight lines for folding on the two sheets using a steel rule and a scribe as shown in fig.1

- Fold the two sheets to an acute angle on the marked line using a hatchet stake, steel plate / hammering block and a mallet to form the hooks as shown in fig.2.

- Make the folded widths flat by filling with a scrap bend sheet of approximately 1.5 times thickness of sheet and pressing with a mallet to get the pocket for lock in two sheets. (Fig.3)

- Interlock the folded sheets and place the sheets on the dressing plate. (Fig.4)
TASK 6: Making a straight edge wired joint by hand process

- Mark and cut sheet as per drawing (ISSH 215 x 95 x 0.6mm G.I. sheet)
- Flatten the sheet using a mallet on a dressing plate.
- De-burr on edges of the sheet.
- Determine the total length of the sheet for edge wired joint.
- Mark two lines parallel to the edge of the sheet metal at a distance of 1/4th of the total wiring allowance.
- Fold at the first line nearer to the edge at right angle on the steel plate or the hatchet stake using a wooden mallet.
- Make an another fold at the second marked line to 30° on a hatchet stake using a wooden mallet.
- Use a wire of given diameter slightly longer than the length of the edge to be wired.
- Place the wire at the folded edge and tap the edge by a wooden mallet using an anvil or anvil stake as base as shown in fig.1
- Press the joint to close down using the wooden mallet, to get the grooved joint (seam) as shown in fig.5
- Select the correct size of hand groover of a given width of lock (seam), as shown in fig.6.
- Place the groover over the fold and strike it using a ball pein hammer, lock the joint and finish. (Fig 7)
- Form the edge around the wire by striking the wooden mallet as shown in fig.2
- Finish the wired edge, on the edge of the anvil or anvil stake by striking the wooden mallet in different direction as shown in the fig.3 & 4.
- Check the locked grooved joint to its requirement.
• Finally, finish the wired edge on a hatched stake as shown in the fig. 5

• Cut off the surplus wire at the ends using hacksaw (Hacksaw blade fitted with hacksaw frame).

---

**TASK 7: Single hemming and double hemming on curved edge**

• Develop and layout the pattern for the cylinder (Fig 1) with all allowances for joining and hemming on drawing sheet by parallel line method.

• Check the pattern for its correctness.

• Ensure the correct size of the material.

• Cut the pattern and paste it on the given sheet metal with gum.

• Cut the pattern with notches using 12" straight snips.

• Deburr the edges using a flat smooth file 150 mm long.

• Form the sheet metal pattern to cylindrical shape using a round mandrel stake and a mallet. (Fig 2) (Ref. Skill Sequence)

• Hook the folded edges and make the lock grooved joint using a hand groover. (Fig 4) (Ref. Skill Sequence)

• Make single hemming on one end and double hemming on the other end of the cylinder using a hatchet stake and Tinman's anvil. (Ref. Skill Sequence)

• Dress the cylinder to regular round shape using a round mandrel stake and a mallet. (Fig 5)

• Check the roundness of the inside diameter of the cylinder using gauge.
Skill Sequence

Folding at right angle using a hatchet stake

Objective: This shall help you to
- fold the sheet metal at right angle using a hatchet stake and a mallet.

Mark the folding line on the workpiece.

Hold the workpiece horizontal by one hand as shown in Fig 1.

Position the marked folding line on the bevelled edge of the hatchet stake.

By other hand, strike the edge of the workpiece at both ends by the wooden mallet, using slightly angular motion.

Ensure that folding takes place at the marked folding lines at both ends.

Lower the end of the workpiece slightly. (Fig 2)

Strike the edge of the workpiece using the same angle of striking.

Strike the edge of the workpiece from one end, progressing gradually, towards the other end. This will give uniform folding.

Single hemming

Objective: This shall help you to
- make single hemming at the edge of the sheet using a hatchet stake.

Fold the edge of the workpiece to approximately 90° using a hatchet stake and a wooden mallet. (Ref. Skill sequence of folding at right angle using a hatchet stake)

Placing the workpiece vertically on the hatchet stake as shown in Fig 1, increase the angle of bend, by striking with the wooden mallet. (Fig 2)

Place a piece of waste sheet and flatten the edge as shown in Fig 3.
Examine the edge for any gap between the edge and the surface of the workpiece. (Fig.5)

Marking and folding

Objectives: This shall help you to
- mark the allowance for double hemming
- do double hemming on the edges of the sheet using a hatchet stake.

Mark the first hemming allowance equal to double hemming dimensions i.e., 2 times the thickness of the sheet to be used.

Fold the sheet metal; edge to be folded more than 90° on the hatchet stake using a mallet. (Fig 1)

Flatten the folded edge on the dressing plate using the mallet. Ensure that there is no gap between the folded edges. (Fig.2)

Mark a line from the folded edge at a distance equal to the thickness of the sheet, providing clearance for the second fold. (Fig 3)

Hold the workpiece vertical, set the marked line matching with the bevelled edge of the hatchet stake and fold the edge to approximately 90° using a mallet. (Fig 4)

Now fold the edge further on the dressing plate using the mallet. (Fig 5)

Flatten the edge, without any gap, using the mallet. (Fig.6)

Check the double hemmed edge for flatness and straightness.

Rectify, if necessary.

Remove the waste piece and edge down the fold by striking it with end faced mallet in angular position as shown in Fig 4.

If any, finish the edge to get uniform hemming.

Do not crush the folded portions excessively while bending otherwise it may crack.
Paned down joint

Objective: This shall help you to
• set the part and finish the paned down joint (single seam).

The setting down operation for the single seam (paned down joint) should be carried out stage by stage as shown in (Fig 1)

While striking, stretching and buckling of the metal is occurred at the bottom edge (Fig 2)

Setting and double seaming

Objectives: This shall help you to
• place the joint on halfmoon stake and square stake
• finish the knocked up joint (double seam)

For knocked up seam, the paned down joint is turned up. Place the paned down joint on a half moon stake and join by a mallet as shown in Fig 1.

Support the job by hand and strike with the mallet all around to an angle as shown in Fig 2.

Increase the angle of the bend gradually, while striking with the mallet all around the seam as shown in Fig 3.

Tighten the double seam (knocked up joint) using the planishing hammer’s shown in Fig 4.

Place the edge of the joint on the square stake and lightly dress the bottom with the planishing hammer as shown in Fig 5.
The Finished double seam (knocked up joint) is shown in Fig 6.

Marking and forming lock grooved joint

Objectives: This shall help you to
• mark the allowance for double hemming
• make double hemming at the edges of a sheet metal using a hatchet stake.

First determine the fold size for the given width of the seam.
Fold size = Width of the lock - 3 times the material thickness.

Now from the fold size determine the total allowance for the locked grooved joint.
Total allowance = (3 x the fold size) + (6 x the thickness of the sheet)

For example, if the width of the lock is 6mm and the thickness is 0.5 mm then, the fold size = 6-(3x0.5) = 4.5mm
The total allowance = (3x4.5) + (6 x 0.5) = 13.5+3=16.5mm.

Mark the line at a distance of 1/3rd of the total allowance on one sheet and two lines at a distance of 1/3rd and 2/3rd of the total allowance on another sheet.

For example, if the total allowance is 16.5 mm then, mark the line at a distance of 5.5mm from the edge on one sheet and two lines at a distance of 5.5mm and 11.00mm from the edge on another sheet (Fig 1)

Fold the workpiece to more than 90° on the hatchet stake using a wooden mallet (Fig 2) and then place the bend sheet of 1.5 times the thickness as shown in Fig 3 and flatten the edge using the wooden mallet. This looks like a hook.

Make a similar hook on the other workpiece also.

Interlock and place the workpiece on the dressing plate. (Fig 4)
While interlocking, ensure that the interlock is parallel and tight at both ends visually.
Press the joint to close down using the wooden mallet, to get the grooved joint (seam). (Fig 5)

Select the hand groover of a given width of the lock (seam). If proper size groover is not used, it may cause improper locking of the grooved joint (Fig 6)

Place the groover over the fold at one end as shown in Fig.7
Hold the hand groover in one hand and strike the top of the
groover with ball pein hammer by the other hand and clinch
the groove. Similarly clinch the groove at the other end.

Advance this work every 1/3 of the groover length, until the
entire groove is clinched down (Fig 8)

Finish the locked grooved joint (seam) with the hand groover
and the hammer.

Making wired straight edge for stiffening by hand process

Objectives: This shall help you to
• calculate the wiring allowance and total length
• form the edge around the wire and finish as a hatchet stake.

Calculate the wiring allowance for the given wire of diameter
‘d’ and sheet thickness ‘t’.

Wiring allowance = 2.5 times the diameter of the wire + the
sheet thickness.

Determine the total length of the side.

Total length = length of the side + wiring allowance.

Cut the sheet metal to the required size using a straight snip.

 Flatten the sheet on the dressing plate by a mallet and
deburr the cut edges by a flat smooth file.

Mark two lines parallel to the edge of the sheet metal at a
distance of 1/4th of the total wiring allowance.

Fold at the first line nearer to the edge at right angle on the
steel plate or the hatchet stake using a wooden mallet.

Make an another fold at the second marked line to 30° on
a hatchet stake using a wooden mallet.

Take a wire of given diameter slightly longer than the length
of the edge to be wired.

Place the wire at the folded edge and tap the edge by a
wooden mallet using an anvil or anvil stake as base. (Fig 1)

Form the edge around the wire by striking the wooden
mallet. (Fig 2)

If the edge is too narrow, give blows in the direction shown
in Fig 3.

If the edge is too wide give blows in the direction shown in
Fig 4.
Forming cylindrical shape by hand process

Objective: This shall help you to
• form a plain sheet to a cylindrical shape by hand process.

Ensure for the correct size and shape of the pattern. (Workpiece)
Fix the mandrel stake on to the bench plate.
Set and bend the workpiece ends parallel to the axial line of the mandrel. (Fig 1)

Gradually rotate and form the entire workpiece to cylindrical shape by hand. (Fig 2 & 2A)
Check the formed cylinder for the roundness of the external diameter using an external gauge. Fig 2 of skill sequence of checking the roundness.

Finally finish the wired edge on a hatchet stake as shown in the Fig 7.
Cut off the surplus wire at the ends.
File the ends of wire using a flat smooth file.

Set the workpiece parallel to the axial line of the stake. If not the edges will not match with each other as shown in Fig 3.
Making lock grooved joint on a cylinder by hand process

Objective: This shall help you to
- make a lock grooved joint on a cylindrical object using hand groover.

Ensure for correct marking on the pattern, for allowances for making the locked grooved joint.

Fix the hatchet stake in the vice or the bench plate.

Place and set the bending line along the bevelled edge of the hatchet stake. (Fig 1)

Set the bending line correctly on the bevelled edge of the hatchet stake, to avoid unequal folding.

Form the hooks at both ends in opposite direction using a hatchet stake and a mallet.

Close down the hooks by light blows using a mallet. This is the grooved seam. (Fig 4)

Lock the grooved seam with a hand groover and a hammer as shown in Fig 5.

Form the sheet to cylindrical shape using a round mandrel stake. (Refer previous skill sequence).

Interlock the hooks at the ends as shown in Fig 3.

Dress the formed cylinder to a regular round shape using a round mandrel stake and a wooden mallet.
Make a single hemming on a curved edge

Objective: This shall help you to

• make a single hemming on a curved edge using anvil stake and setting hammer.

Mark the hemming allowance on the formed body using a marking template.

Fix the anvil stake on to the vice or bench plate.

Hold the workpiece such that the marked line coincides with the edge of the stake approximately inclined at an angle of 10° as shown in (Fig 1).

Strike and rotate the workpiece gradually along the marked line to form a small flange using a setting hammer. (Fig 2)

Gradually increase the angle of inclination while forming the flange as shown in Fig 3.

Finish the hemmed edge on a round mandrel stake by a mallet. (Fig 4)

Dress the disturbed body of the cylinder to a round shape using a round mandrel stake and a mallet.
Punch holes using hollow and solid punches

Objectives: At the end of this exercise you shall be able to
• punch holes using hollow punches
• replace damaged gasket
• punch holes using solid punch.

RUBBER SHEET 2.0 THICK

TASK 1
TASK 2

Ø6 - 2 HOLES (HOLES TO BE PUNCHED WITH SOLID PUNCH)

30

25

90

1.6

30

R/15

PUNCH HOLES USING SOLID PUNCH

Capital Goods & Manufacturing - Fitter : Exercise 1.3.46
Job Sequence

**TASK 1: Punch holes using hollow punch**
- Cut the rubber sheet to the size of 78x48x2mm.
- Mark the dimensions to locate the hole centres using steel rule and pencil.
- Mark the geometrical shape of gasket as shown in figure (Fig.1.3.46)
- Draw the circles (holes) and arcs using a compass.
- Mark the geometrical shape of gasket as shown in figure (Fig.1.3.46)
- Locate the hollow punch cutting edge, to seat on the periphery of the circles marked for holes. (Fig.1)
- Strike on hollow punch to cut the holes using a ball pein hammer.
- Cut the periphery of the gasket using scissors.
- Check for the correctness of dimensions.

**TASK 2: Punch holes using solid punch**
- Check the size of the raw material using a steel rule.
- File the burrs on the cut edges of the sheet metal workpiece by a flat file smooth 250 mm.
- Flatten the job material on a Tinman’s anvil using a wooden mallet Ø75.
- Check the flatness of the job material by a trysquare (Fig 1 in skill sequence).
- Mark straight lines with a scribe using a steel rule.
- Mark bend lines a’, b’, c’, d’ on both sides of the workpiece, reducing for face A and E one time thickness of sheet and face B, C and D, 2 time thickness of sheet from the clamp dimensions as shown in Fig 1.
- Mark points ‘X’ and ‘Y’ and indent with center punch and ball pein hammer. Mark curved lines using wing divider. (Fig 1)
- Cut along straight and curved lines by straight snips.
- File the burrs on the cut edges of the job by flat file smooth 250 mm.
- Clamp the face B of the job the folding line just above 1/2 time thickness of sheet in folding bars, hold in bench vice and fold the face A at right angles using the wooden mallet Ø75. (Fig 2&3)
- Remove the job, by loosening the jaws of the vice.
- Similarly, clamp face D of the job in folding bars held in benchvice and fold face E at right angle using the wooden mallet ø75. (Fig 4)

![Fig 4](image1.png)

- Remove the job, by loosening the jaws of the vice.
- Clamp face C of the job in a pair of angle irons, held in benchvice and fold face B at right angle using the wooden mallet ø75. (Fig 5)

![Fig 5](image2.png)

- Remove the job, by loosening the jaws of the bench vice.
- Similarly, clamp face 'C' of the job in angle irons held in bench vice and fold face 'D' at right angle using the wooden mallet ø75 (Fig.6)

- Check the perpendicularity of all the bends using a trysquare.
- Rectify the perpendicularity, using a wooden mallet and a suitable wooden support, if folds are not perpendicular.

![Fig 6](image3.png)

- Mark locating points with a scriber and punch using a dot punch and a ball pein hammer. (Fig.7)
- Place the job over a lead cake.
- Hold the solid punch ø6mm on the located points in vertical position by one hand.
- Strike the head of the solid punch with the ball pein hammer by other hand, with sufficient striking force.
- Repeat striking the hammer, till you get the hole.
- File the burr on both sides of the job, using a smooth round file.
- Planish the punched area of sheet on a tinman's anvils for flatness.

![Fig 7](image4.png)
Introduction

After continuous use, the cutting edges of a solid punch gets blunt. In order to get the punch for reuse, the punch is resharpened.

Resharpening is done on a bench or a pedestal grinder. Grinding is done on face and tapered diameter of the solid punch.

Before grinding, ensure that the grinding wheel is properly dressed and the wheel is true.

Ensure that the gap between the grinding wheel face and the tool rest is approximately 2 mm.

Hold the solid punch on the tool rest, perpendicular to the face of the grinding wheel. (Fig 1)

Grind the face of the punch slowly by rotating it in clockwise direction. While rotating, hold the punch rigidly on the tool rest and see that excessive force is not applied while grinding.

Continue grinding till the face of the punch becomes flat.

Now hold the punch at an angle as shown in Fig 2 and grind slowly the diameter of the solid punch by rotating the punch clockwise. While grinding see that the punch is held tangential and the diameter of the punch is just touching with light force to the face of the grinding wheel. Rotate the punch uniformly for proper grinding of the diameter.

Position the punch such that the four locating points, coincide with the circular cutting edges of the punch, otherwise the centre of the punched hole will get displaced.

Use a lead cake or a cross grained wooden block as a supporting base. While striking, watch the cutting point and not the head of the punch.

While striking the hammer, ensure that, the hammer strikes at the centre of its bottom face and top face of the punch. Otherwise, the position of the punch gets disturbed and oblong hole is produced. Sometimes, the punch may slip off from its position and cause accident.

While using wooden block as the supporting base, the sheet should be placed at gross grained end of the wood, otherwise, distortion is caused. (Fig 2)

A punched hole diameter reduces slightly, when the sheet is flattened after punching. Finish the punched hole, file the burr, then planish the bulging caused due to punching. (Fig 3)

A punched hole diameter reduces slightly, when the sheet is flattened after punching. Finish the punched hole, file the burr, then planish the bulging caused due to punching.

Resharpening of a solid punch

Objective: This shall help you to
• resharpen the blunt cutting edges of a solid punch on a bench grinder and pedestal grinder.

Introduction

After continuous use, the cutting edges of a solid punch gets blunt. In order to get the punch for reuse, the punch is resharpened.

Resharpening is done on a bench or a pedestal grinder. Grinding is done on face and tapered diameter of the solid punch.

Before grinding, ensure that the grinding wheel is properly dressed and the wheel is true.

Ensure that the gap between the grinding wheel face and the tool rest is approximately 2 mm.

Hold the solid punch on the tool rest, perpendicular to the face of the grinding wheel. (Fig 1)

Grind the face of the punch slowly by rotating it in clockwise direction. While rotating, hold the punch rigidly on the tool rest and see that excessive force is not applied while grinding.

Continue grinding till the face of the punch becomes flat.

Now hold the punch at an angle as shown in Fig 2 and grind slowly the diameter of the solid punch by rotating the punch clockwise. While grinding see that the punch is held tangential and the diameter of the punch is just touching with light force to the face of the grinding wheel. Rotate the punch uniformly for proper grinding of the diameter.

Use a lead cake or a cross grained wooden block as a supporting base. While striking, watch the cutting point and not the head of the punch.

While striking the hammer, ensure that, the hammer strikes at the centre of its bottom face and top face of the punch. Otherwise, the position of the punch gets disturbed and oblong hole is produced. Sometimes, the punch may slip off from its position and cause accident.

While using wooden block as the supporting base, the sheet should be placed at gross grained end of the wood, otherwise, distortion is caused. (Fig 2)

A punched hole diameter reduces slightly, when the sheet is flattened after punching. Finish the punched hole, file the burr, then planish the bulging caused due to punching. (Fig 3)
Do lap and butt joints

Objectives: At the end of this exercise you shall be able to
- set and tack lap joint in correct alignment
- solder a lap joint, in flat position using soft solder
- solder a fillet and butt joint in flat position using electric soldering iron.
**Job Sequence**

**TASK 1: Soldering lap joint**
- Cut two pieces of sheet metal to the size 75x50x0.5mm.
- Check the size of the material using a steel rule and squareness with a try square.
- Place two pieces one over the other as shown in job drawing. Prepare the portable hand forge with charcoal and fire with blower.
- Heat the soldering copper bit and tin the working point of it.
- Tack and solder the joint.
- Clean the joint using water to remove the oxides.

**TASK 2: Soldering butt joint**
- Cut the material in three pieces as per the job drawing.
- Make the single plated butt joint using an electric soldering iron as per the job drawing.
- Clean the job using water to remove the oxides.

**Skill Sequence**

**Method of soft soldering**

**Objective:** This shall help you to
- make a joint by soft soldering.

**Soft soldering**

Clean the area to be joined thoroughly

Where a lap joint is required on mild steel, both sides of the top lap should be cleaned and tinned, to assist heat transfer when soldering.

Heat the copper of the soldering iron until the flame is bright green. Keep the edge of the copper bit upward. (Fig.1)

Place the sheet on a soldering bench.

Apply the flux on the area to be joined. (Fig.4)

Dip the edge of the bit in flux solder-acid. (Fig.2)

Dip the point into the flux. This will remove the oxide film from the finned faces.

Apply the solder to the point. (Fig.5)

Apply the bit to the work.

Spread the solder evenly on the surfaces.
Keep the tinned face of the bit flat, to obtain maximum heat transfer.
Apply more solder as required.
Turn the sheet over and tin the other lap area in the same manner.
Using a wet rag, clean off the excess flux.

Making a single plated soldered butt joint

Objectives: This shall help you to
- set and tack single plated butt joint in correct alignment using electric soldering iron
- solder a fillet and butt joint of correct size in flat position using electric soldering iron.

Check the size of three sheet metal pieces by using a steel rule.
Select a suitable type of an electric soldering iron.
Check if it has loose components connections, frayed or damaged insulation. If found, replace the soldering iron. Short circuiting because of the above faults may cause shocks and fires. (Fig 1)

Do not attempt yourself to repair it. Repairs should be carried out by a qualified electrician.
Plug it in the socket of the switch board and switch ‘ON’.
Place the electric soldering iron on a suitable support stand. (Fig 2)

Select the suitable flux for the job.
Select the suitable solder for the job.
Clean the surface to be joined.
Apply the flux to the joint by using a brush.

Layout three sheet metal pieces to obtain single plated butt joint as per the job drawing.
Place the electrical soldering iron such that its lead does not come across sharp edges of the metal pieces. (Fig 3)
Tin the point of electric soldering iron by rubbing it on a soft solder.

Tinning on the bit should be bright and should cover the faces of the tip completely.
Set and tack the three metal pieces in correct alignment.
Solder the butt edge at the bottom and cover the plate edges at the top. (Fig 4)

Switch off the power, then remove the plug from the switch board after soldering is completed.
Clean the job in cold water to remove the oxides.
Check the joint and rectify, if required.
Bend sheet metal into various curvature forms - Funnel

Objectives: At the end of this lesson you shall be able to
• prepare the radial line development and pattern for the funnel
• mark the sheet metal with flap dimension for hemming
• fold the sheet metal at angle 90°
• cut the sheet metal as per the dimension given
• bend to form the conical portions in various dimensions
• prepare the wired edge to complete funnel (ferrule).

**Task 1**

**Make a Funnel**

<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>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Ø2 - 380</td>
<td></td>
<td>G.I WIRE</td>
<td></td>
<td></td>
<td>1.348</td>
</tr>
<tr>
<td>1</td>
<td>ISSH 160 x 25 x 0.5</td>
<td></td>
<td>G.I SHEET</td>
<td></td>
<td></td>
<td>1.348</td>
</tr>
<tr>
<td>1</td>
<td>ISSH 335 x 30 x 0.5</td>
<td></td>
<td>G.I SHEET</td>
<td></td>
<td></td>
<td>1.348</td>
</tr>
<tr>
<td>1</td>
<td>ISSH 125 x 80 x 0.5</td>
<td></td>
<td>TINNED - SHEET</td>
<td></td>
<td></td>
<td>1.348</td>
</tr>
<tr>
<td>1</td>
<td>ISSH 250 x 140 x 0.5</td>
<td></td>
<td>TINNED - SHEET</td>
<td></td>
<td></td>
<td>1.348</td>
</tr>
</tbody>
</table>

**SCALE:** NTS

**PROJECT:** FUNNEL

**PART:** 1, 2, 3 & 4

**CODE NO.:** FN134BE1

**DEVIATIONS:** ±1mm  **TIME:** 7hr

166
MAKE A FUNNEL
(SEAMING THE BODY AND THE TAIL)

PROJECT: FUNNEL
PART: 1. BODY 2. TAIL

SCALE 1:2

NO.OFF - - - - - - - 1.3.48
STOCK SIZE - - - - - - -
SEMIPRODUCT - - - - - - -
MATERIAL - - - - - - -
PROJECT NO. - - - - - - -
PART NO. - - - - - - -
EX. NO. - - - - - - -

DEVIATIONS ±1mm
TIME:

CODE NO. FIN1348E2

Capital Goods & Manufacturing - Fitter: Exercise 1.3.48
PART 3-FERRULE

MAKE A FUNNEL

PROJECT: FUNNEL
PART: FERRULE

CODE NO. FIN1348E3

SCALE 1:1

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

- - - - - - 1.3.48

DEVIATIONS ±mm TIME:

168
FORMING THE HANDLE

PART 4- HANDLE

3mm HEMMING BOTH SIDES

R15

R60

15

6

60

10

30°
FOLDING SHEET METAL AT ANGLE 90°
IN HATCHET STAKE
Job Sequence

Task 1: Make a funnel

Part 1 (Funnel Body)
- Develop and layout the pattern for the body of a funnel (frustum of a cone) with joining allowances on a plain drawing paper using a geometry box (instrument box).
- Cut the layout pattern using scissors and paste it on the given raw material (sheet metal) using fevicol/gum.
- Cut the sheet metal on the outlines of the layout pattern of the paper so pasted, using a straight and bend snips.

Part 2 (Funnel Tail)
- Develop and layout the pattern for the tail of funnel (frustum of a cone) with all allowances for joining on a plain drawing paper using a geometry box (Instrument box).
- Cut the layout pattern using scissors and paste it on the given sheet metal using fevicol/gum.
- Cut the sheet metal on the outlines of the layout pattern of the paper so pasted, using a straight and bendsnips.

Part 3 (Funnel Ferrule)
- Cut the sheet metal to the size 335x30, flatten the sheet and deburr the cut edges.
- Refer the skill sequence for development 1.3.43 of cylinder.
- Develop the pattern layout on sheet considering the wiring allowance for 2mm dia. wire, the seaming allowance for 4mm locked groove joint and cut the pattern with clips using a straight snip.
- Form the circular shape with locked grooved joint using a round mandrel stake, a hand groover, a ball pein hammer and a mallet.
- Make a 2mm dia wired edge along the circular edge of the ring using a half moon stake and a setting hammer.
- Dress and check the ring for shape and dimensions.

Part 4 (Funnel handle)
- Make a handle (Part 4) as per drawing using funnel stake and mallet.

Assembly of funnel
- Bend the joining allowance at larger end of body (Part 1) using anvil stake and mallet. (Fig. 1)
- Insert the ferrule (Part 3) in body (Part 1) and solder.
- Solder the lap joint of the tail. (Part 2)
- Flare 4mm edge of the larger dia end of the tail (Part 2) to position it securely into the body.
- Insert the tail in the body and solder.
- Position the handle (Part 4) and solder as per job drawing.
- Inspect the finished article for sharp edges, burr or any irregularity and rectify if necessary.
- Wash the article with cold water.

Task 2: Folding the sheet metal to 90°
- Cut the job material 135x48 mm using a straight snip.
- Mark the job material with a scriber using a steel square. (Fig. 1)
- Position the marking line to the edge of the bevelled hatchet stake.
- Strike the edge using mallet by holding the other end of the job.
- Ensure the folding takes place on the bend line as required.
- Continue to strike the job to fold at 90° angle.
- Check the perpendicularity of the job by a try square.
- Rectify the perpendicularity, using a wooden mallet, supporting the job on a hatchet stake, if required.
While drawing the plan, the neutral plane (outer diameter plate thickness) of the base circle is taken as the diameter.

The neutral plane size is negligible, if the plate thickness is less than 0.5 mm.

Divide accurately the circumference of the plan into 12 equal parts. (Fig 3)

With the radius of the circle, first divide the circumference into 6 equal parts.
Then divide each part into two.
Draw a perpendicular line on the material. (Fig 4)

Skill Sequence
Development for a circular cone

Objective: This shall help you to
- develop a circular cone by the radial line development (Fig 1).

Circular cone: Draw the front elevation and the plan. (Fig.2)

While drawing the plan, the neutral plane (outer diameter plate thickness) of the base circle is taken as the diameter.

The neutral plane size is negligible, if the plate thickness is less than 0.5 mm.

Divide accurately the circumference of the plan into 12 equal parts. (Fig 3)

With the radius of the circle, first divide the circumference into 6 equal parts.
Then divide each part into two.
Draw a perpendicular line on the material. (Fig 4)

Draw a perpendicular line to the centre of the material blank space.
Transfer the length of the edge line (slant height) to the compass. (Fig 5)

Transfer it accurately.

Draw an arc with the centre at a point on the perpendicular line (Fig 6) and the slant height as the radius.

Check the opening of the compass with each equally divided points, to minimise errors.
Open the compass points to one of the 12 equally divided parts of the circumferential length.
Open the compass by checking each equally divided point to minimise errors.
Scribe 12 opening points of the compass on the arc.
Scribe six points on both the right and left sides of the perpendicular respectively. (Fig 7)
Use the compass points alternately while scribing points, without removing the compass from the arc at a time.

Connect the right and left ends of the arc to the centre. (Fig.8)

Fig 8 shows the development for the given cone.

**Develop and layout the pattern for the frustum of a cone by radial line method**

**Objective:** This shall help you to
• develop and layout the pattern for the frustum of a cone by radial line method.

Get a plain drawing paper large enough to make the flat pattern layout.

Draw the elevation of the frustum of a cone in full size ‘AGMN’ in Fig 1.

Continue the lines showing taper sides of the body till they intersect at a point ‘O’. ‘O’ is called as an ‘Apex’. (Fig 1)

Taking O as the centre and O’A as radius, draw an arc AG and divide it into six equal parts A-B-C-D-E-F-G. (Fig 2)

With centre ‘O’ draw arcs ‘AX’ and ‘NY’. X&Y are the points on the centre line of the frustum of a cone. (Fig 3)

Take distance ‘X’ and mark off twelve lines along the arcAX to obtain A1-B1-C1-D1..... to D2-C2-B2....A2. (Fig 3)

Join the points A1, B1, C1, .... C2, B2, A2 to the point ‘O’
The development required is A1A2 N1N2.

This is the development of a frustum of a cone without a joining allowance.

Now add joining allowances ‘a’ & ‘b’ by drawing lines parallel to A1N1 & A2 N2. (Fig 4)

Add hemming or wiring or joining allowance ‘c’ & ‘d’ by drawing arc inside the arc N1 N2 and outside the arc A1 A2. (Fig 4)

**PART 1 (Body)**

• Flatten the sheet metal using a wooden mallet and a Tinmans anvil stake. Fig 1)

• Check the allowances for the locked grooved joint using a steel rule.
• Form hooks on both the ends in opposite directions by using a hatchet stake, a wooden mallet and a 1/2 lb ball pein hammer.

• Form the sheet metal to the frustum of cone by using a funnel stake. (Fig 3)

• Make a locked grooved joint by using a funnel stake, a hand groover and a 1 1/2 lbs ball pein hammer. (Fig 4)

• Finish the job using a wooden mallet.

• Check the dimensions of the job by using a steel rule.

Part 2 (Tail)

• Flatten the sheet metal using a wooden mallet and a Tinmans anvil stake. (Fig 5).

• Check the allowance for the lap joint by using a steel rule.

• Form the sheet metal into frustum of cone using a long tapered beak frustum of cone with a long tapered beak horned iron stake. (Fig 6)
Forming a frustum of a cone with locked grooved joint

Objectives: This shall help you to
• form a frustum of cone using a funnel stake and a wooden mallet
• make locked grooved joint on tapered curved surface using a funnel stake, hand groover and a ball pein hammer.

Check the pattern and ensure that all the required allowances are provided by using a steel rule as per the job drawing. (Fig 1)

Remove burrs by using a flat file. Mount the hatchet stake on the bench plate.

Place the sheet horizontally on the hatchet stake edge at the line marked previously for folding.

With a wooden mallet strike the edge of the job on both ends. (Fig 2) Observe break or fold mark formed.

Lower the end of the work slightly using the same angle of striking, increasing the angle of turning.

Repeat the above operation till the edge is turned to the required angle. (Fig 3)

For turning more than 90°, support the work flat against the face of the stake.

Grip the stake with fingers at ‘A’ and hold the work in position with the thumb. (Fig 4)

Mallet the edge over a piece of waste tin plate. (Fig 5)

Repeat the same operation on the other edge of the sheet and form hooks. (Fig 6)

Mount the funnel stake on a bench plate. (Fig 7a) Use “long tapered beak horned iron stake” for the cones having small radius, plate. (Fig 7b & 7c)
Repeat the same operation on the other end of the workpiece. Bend the workpiece evenly as shown in (Fig 9).

Ensure that the folded edges of the workpiece are parallel, if not the edges will not match as shown in (Fig 11).

Hook the folded edges as shown in Fig 12.

Slowly lock the edges by light blows using a mallet as shown in (Fig 13). Start blows from one end of the joint to the other end to tighten the joint. (Now grooved seam is formed)

Select the correct size of the groover.

Check the turned up edge of the circular disc and curve it gradually and make both ends to meet together. (Fig 10)

Place the groover over the grooved joint as shown in (Fig 14)

Position the groover at a very slight angle. The edge of joint acts as a guide to the groover. (Fig 15)

Bring the groover to vertical position. (Fig 16)
Strike the top of the groover firmly with ball pein hammer and lock same on the other end. (Fig 17)

Check the ends again to ensure that they are in line. Continue to lock the seam along the line with the hand groover.

Now the joint is fully locked. (Fig 18)

Finally smoothen with a mallet all over the body and check the dimensions as per the job drawing by using a steel rule. In order to get proper setting of seam of the required size, it is necessary to use the correct size of a groover. If not, the seam is set too wide or too narrow. Figs 19, 20 & 21.

**Making wired edge along a curved surface by hand process**

**Objectives:** This shall help you to
- mark the wiring allowance at the curved edge
- make a wired edge along a curved surface by hand process

Mark the wiring allowance at the curved edge to be wired using a gauge with sheet metal as shown in Fig 1.

Flange the edge to be wired using a hatchet stake and a setting hammer, step by step up to 90°. (Fig 2) Then upset the flange to its half the width and make curve on the flange for wiring. (Fig 3)
Objectives: This shall help you to
• fold the sheet metal workpiece at right angle, in straight line, maintaining correct dimensions of the folded sides, using folding bars.

Introduction
Folding bar is one of the holding tool used for folding sheet metal. (Fig 1)

Hold the sheet metal workpiece between the legs of the folding bars by one hand such that the marked bending line coincides with the top edge of the folding bars and tighten the jaws gently by turning the handle of the vice by another hand. (Fig 2)

Ensure that the bending line coincides with the top edges of the folding bar. If not, adjust it with the help of a wooden mallet.

Tighten the jaws of the bench vice fully.

Then fold the sheet metal part above the folding bar to the required direction by striking with the wooden mallet with required force, gradually along the bending line from one end of the sheet to the other. (Fig 3 and 4) (Fig 2 of skill sequence folding using angle iron).

While folding, always direct the wooden mallet or the hammer to blow towards fixed jaws, otherwise the position of the workpiece and the folding bars may get disturbed.

Fold at right angle using folding bars

Make a round ring from the given G.I. wire to the required dia. (Fig 3)

The joint of the wire should be opposite to the locked grooved joint.

Complete the wiring using a creasing hammer. (Fig 5)

Redress the trueness of the cylindrical shape by a round mandrel and a mallet.

Dress the wiring by using a half moon stake and a mallet.

Place the G.I. Wire ring on the flange. (Fig 4)

Place the G.I. Wire ring on the flange. (Fig 4)

Complete the wiring using a creasing hammer. (Fig 5)
While striking with the wooden mallet, ensure that the striking force is not excessive.

Check the perpendicularity of the fold after folding using a try square. If slight error is observed, rectify it with a wooden mallet, using a suitable wooden support.

If necessary complete the folding by flattening the bend surface using a flattening piece with a setting hammer (Fig.3) of skill sequence of folding by angle iron.

**Fold at right angle using an angle iron**

**Objectives:** This shall help you to
- fold a sheet metal workpiece at right angle, in straight line, maintaining correct dimensions of the folded sides, using an angle iron.

**Introduction**

A pair of mild steel angle iron of suitable standard size is used for folding sheet metal.

This process of folding a sheet metal is similar to the folding using folding bars. Only difference in this process is a pair of mild steel angle iron of suitable size is used in the place of folding bars and additional clamping using C clamp is provided at another end.

Fig 1 shows clamping the workpiece

Fig 2 shows folding the workpiece

Fig 3 shows flattening the folded side.
Objective: This shall help you to
• check the perpendicularity between two sides using a try square.

Introduction
Perpendicularity is a unit of measurement, which indicates the deviation of two sides/edges meeting at right angle from 90°.

Generally in sheet metal working, perpendicularity is measured by a try square or a steel square.

Place the stock of the try square on one side of the workpiece at the bend.

Compare the other side of the workpiece with the edge of the blade of the try square visually.

When no gap is (Fig 1) observed, then the two sides are said to be perpendicular. (Fig 1)

If the gap is observed, the workpiece is to be rectified, using a wooden mallet and a suitable wooden support. (Fig 1a)

If the inside bend radius is larger, then use the try square from the outside of the bend for correct checking of the perpendicularity.
Make simple square container with wired edge and fix handle

Objectives: At the end of this exercise you shall be able to
- develop the pattern for square container
- prepare the square container with lid by knocked up joint and locked grooved joints
- make the cover plate and handles for container
- finish the container with wired joint.
TASK 2

SQUARE CONTAINER
PART: 2 LID

TOLERANCE: ±1mm
TIME: 17Hrs

CODE NO. FIN1348E2

1
ISSH 400 x 400 x 0.61
- GI SHEET

1.3.49
TASK 2

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

SCALE 1:1
TASK 3

PART - 3
HANDLE COVER PLATE

Ø3 HOLE

TASK 4

PART - 4
HANDLE

<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>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Ø6 x 270</td>
<td></td>
<td>M.S. WIRE</td>
<td></td>
<td></td>
<td>TASK 4</td>
</tr>
<tr>
<td>3</td>
<td>ISSH 80 x 85 x 1.2</td>
<td></td>
<td>G.J.SHEET</td>
<td></td>
<td></td>
<td>TASK 3</td>
</tr>
</tbody>
</table>

SCALE NTS

PART: 3 HANDLE COVER PLATE
PART: 4 FRONT HANDLE

DEVIANES ±1mm 
TIME: 
CODE NO. FIN1349E3

Capital Goods & Manufacturing - Fitter : Exercise 1.3.49
**Job Sequence**

**TASK 1: Development of square container body**
- Develop and layout the pattern by parallel line method, considering the wiring allowance. Locked grooved joint and knocked up joint for the body and bottom as shown in the fig.1.

![Fig 1](image)

- Cut the layout pattern using scissors for body and bottom.
- Paste the pattern on sheet metal.
- Cut the sheet metal on the outline of layout pattern pasted to the sheet using straight snips.
- Cut straight notch at bend line upto the hemming line at both ends of the body.
- Prepare the hem at bottom of the body to fix bottom sheet and locked grooved joint.
- Prepare the hem to fold as flange for knocked up joint.
- Fold the sheetmetal against the angle iron/folding bar/square stakes suitably clamped.
- Strike with wooden mallet, gradually along the bend line.
- Check using a try square/steel square and continue to form the square body of the container.

**TASK 2: Development of square container lid**
- Develop and layout the pattern by parallel line method, considering the hemming allowance and also fit into the body. (Fig.1)

![Fig 1](image)

- Cut the layout pattern, square cover using scissors.
- Paste the pattern on sheet metal.
- Cut out the sheetmetal on the outline of layout pattern pasted to the sheet using straight snips.
- Cut the notch at 45\(^\circ\) in four sides for hemming as shown in figure.
- Bend the hemming on four sides of the cover sheet using square stakes.
- Bend the flange on four sides of the cover sheet using square stakes.
- Solder the four corners using soft solder.

**TASK 3: Development of square container bottom sheet**
- Develop and layout the pattern by parallel line method, considering the hemming allowance and also to fit into the body as shown in fig. 2

![Fig 2](image)

- Cut the layout pattern of square container bottom sheet using scissors.
- Paste the pattern on sheet metal.
- Cut out the sheet metal on the outline of layout pattern pasted to the sheet using straight snips.
- Cut the square notch all four sides for hemming as shown in figure.

Capital Goods & Manufacturing - Fitter : Exercise 1.3.49
Skill Sequence

Calculate the length of material for bending

Objectives: This shall help you to
- state the effects due to bending
- calculate the required length of metal 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. (Figs 1 and 2) Due to the force of pressure in the inner part of the material at the bending point, the material is compressed.

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 distance 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
= inner radius + (0.5 x thickness of sheet) OR diameter of rod or pipe. Angle of the bend with respect to Figs 3 & 4 is 90.

Radius of the bend up to neutral axis.
Radius of the bend up to neutral axis = inner radius + (0.5 x thickness of sheet OR diameter of rod or pipe) angle of the bend with respect to 90°. (Figs 5 & 6)

Radius of the bend up to neutral axis,
=inner radius +(0.5 x thickness of round rod)
Radius of the bend upto neutral axis.
=6+(0.5x6)mm
6+3.0mm
=9mm
∴  Radius of the bend up to neutral axis = 9mm

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

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

∴  Stretch length of one bend = \[ \frac{\text{Angle of curve} \times 2\pi R}{360} \]

\[ \therefore \text{Stretch length of four bends} = 4 \times \frac{90}{360} \times \frac{22}{7} \times 9 \text{mm} \]
= 56.57mm

Straight portion length,
For the length of 'A'
A = 90-(6+6) mm
= 90-12mm
= 78mm

For the length of 'B',
B = 50-(6+6) mm
= 50-12mm
= 38mm

Total length
For the length of 'C'
C = 30-6mm
= 24mm

For the length of 'D'
D = 30-6mm
= 24mm

For the length of 'E'
E = 50-(6+6) mm
= 50-12mm
= 38mm

Total length of the \( \phi \) 6mm round rod=length of A+B+C+D+E+stretch length of four bends.

=78+38+24+24+38+56.57mm
=258.57mm

Total length of the round rod = 258.57mm.

Front handles
Calculate the length of the round rod to make front handles 3 Nos. as per shown in the figures (Ref. skill sequence Part 4 in Ex.No.1.3.49)

Mark the length of rod required as per calculation.
Cut the length rod using hack saw. (Fig.7)
File the ends of rounded rod to remove the burrs.
Mark the dimension for bending length. (Fig.8)
Set the round rod in bending fixture.

Instructor to arrange suitable bending fixture

Bend the round rod to form 90° (Fig.9)
Check the bent angle 90° using bevel protractor. (Fig.10)

Set the round rod to 50mm from the bent leg to 90°. Bend the round rod to 50mm as per shown in Fig.11.

Set the round rod to 90mm from the bent leg to 90°. Bend the round rod to 90mm as per shown in the fig 12.

Set the round rod to 50mm from the bent leg to 90°. Bend the round rod to 50mm as per shown in the figure. (Fig.13)

Check the dimension of front handle using steel rule. (Fig.14)

Similarly, complete the remaining two front handles following the above job sequencies.

Capital Goods & Manufacturing - Fitter : Exercise 1.3.49
Handle cover plate

Calculate the length and width required to make the handle coverplate.

Mark centres of holes as per job drawing.

Cut the sheet using straight snip.

Deburr the edge.

Form 'U' groove in the middle of the sheet using suitable round rod.

Drill Ø3mm hole on the centres as shown in fig.15
Make square tray with square soldered corners

Objectives: At the end of this exercise you shall be able to
• develop layout the pattern of square taper tray
• make a single hem on the edges using folder bar
• fold the sides of taper tray at 60° using pair of angle iron
• solder the four corner of square taper tray.
Job Sequence

- Check the size of the sheet metal as per job drawing using a steel rule.
- Flatten the sheet metal piece on the dressing plate using a wooden mallet.
- Develop and layout the pattern for the tray, considering allowance for the flanges and single hem, on sheet metal by geometrical construction method using a scriber, steel rule, protractor and divider. (Fig.1)
- Cut the sheet metal as per the pattern layout on the sheet metal using a straight snip.
- Fold 6mm edges to make single hems on the four sides on the barfolder.
- Fold 15mm sides at 60° to make flanges on the four sides of the taper tray on the barfolder.
- Fold 46mm four sides, at 60° as shown in the job drawing, using a pair of angle iron, a benchvice, a ‘C’ clamp and a wooden mallet.
- Check the angle of the tapered sides using a bevel protractor and rectify, if necessary.
- Solder four corners of square tray.

Skill Sequence

Preparing the pattern layout

Objectives: This shall help you to
- calculate the developed length and width for square taper tray
- develop the pattern layout.

Let us take the same job for better illustration.

Calculate the developed dimension of a square taper tray.

Given

Side of square 200mm
Flange length = 15mm
Let us take the single hem as 6mm and calculate the slant height.

AB is the slant length.

Given AC=40mm (Fig.1)

\[
\sin 60° = \frac{AC}{AB}
\]

\[
0.866 = \frac{40}{AB}
\]

\[
AB = \frac{40}{0.866}
\]

\[
AB = 46.18\text{mm}
\]

Developed size = Side length of square + 2(slant height + flange length + single hem allowance)

\[
= 200 + 2(46 + 15 + 6)
\]

\[
= 200 + 2(67)
\]

\[
= 200 + 134
\]

\[
= 334\text{mm}
\]

Mark and cut the sheet metal to the size square 334mm.
(Fig.2)

Draw the centre line of length and width XX and YY respectively. (Fig.3)

Draw the base length and width at the centre of the sheet metal workpiece, marking lines at 100mm on both sides of YY and 100mm on both sides of XX. (Fig.3)
Draw lines for 46mm slant height of the four sides of square taper tray parallel to AB, BC, CD and DA shown in the Fig.4.

Draw lines for 15mm flange and 6mm single hem allowance on the four sides parallel to EF, FG, GH and HE as shown in the Fig.5.

Draw lines at an angle of 30° at points A, B, C, D at both ends of lines AB, BC, CD and DA as shown in Fig.6.

Draw lines at an angle of 60° at points I, J, K, L, M, N, O, P as shown in Fig.6

Cut the unwanted portion of the pattern shown by shadow in Fig.6.
Practice on soft soldering and silver soldering

Objectives: At the end of this exercise you shall be able to
• heat the copper bit of soldering iron using blow lamp
• set and tack a sunk lap joint in correct alignment
• solder a sunk lap fillet of correct size in flat position
• prepare the copper tube joints with bell mouth
• solder with silver brazing rod.

SOLDERED SUNK LAP JOINT

TABLE 1

<table>
<thead>
<tr>
<th>NO.</th>
<th>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>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>ISSH 155 x 55 x 0.5mm</td>
<td>-</td>
<td>G.I SHEET</td>
<td>-</td>
<td>-</td>
<td>1.3.51</td>
</tr>
</tbody>
</table>

SCALE 1:1

DEVIATIONS ±1mm
TIME: 5hrs

CODE NO. FIN1351E1
Title: Silver Soldering

<table>
<thead>
<tr>
<th></th>
<th>Ø1.5 x 1 m</th>
<th>-</th>
<th>Silver Brazing Filler Rod</th>
<th>-</th>
<th>-</th>
<th>1.3.51</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>IS 2376 - Ø20 x 1 - 25</td>
<td>-</td>
<td>CUDPA-0</td>
<td>-</td>
<td>-</td>
<td>1.3.51</td>
</tr>
</tbody>
</table>

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

Scale: 3:4

Deviation: ±1mm

Time: 5Hrs

Code No. FIN1351E2
Job Sequence

TASK 1: Sunk lap joint
- Check the size of the material.
- Make the sunk lap joint by using hatchet stake, a wooden mallet and a setting hammer.
- Light the blow lamp.
- Heat the copper bit using a blow lamp.
- Solder the joint.
- Wash the job using water to remove the oxides.

TASK 2: Silver soldering
- Obtain the pipe pieces as per drawing and clean them.
  Ensure the use of all safety devices.
- Make a bell-mouth (Flare) at one end of the pipe and insert the other pipe in.
  Ensure the fitting of pipes is in alignment.
- Apply silver brazing flux along the root of the joint.
- Hold the joint in a vertical position in a bench-vice on a welding table.
- Set the gas welding plant with a small size nozzle.

Skill Sequence

Lighting the blow lamp safely

Objective: This shall help you to
- heat the soldering iron using a blow lamp.

Blow lamp (Fig 1)

Check the level of kerosene in the tank. Refill if necessary. Make the tank 3/4th full for safety.
Clean the jet with pricker.
Close the pressure relief valve.
Fill the priming trough with methylated spirit.
Take care not to overfill the spirit to avoid fire hazards.

Give two to three strokes to pump for priming the lamp.
Light the spirit.
Operate the pump about six to eight times to pressurize the tank after the spirit gets burnt.
If the liquid kerosene is emitted from the jet at this stage, quickly open the pressure relief valve.
Recommence the starting procedure.
Light the lamp at the top of burner housing.
Activate the pump during use, to maintain constant flame.
If the lamp is blown out by wind or extinguished, open the pressure relief valve immediately. This prevents the inflammable kerosene vapour from escaping in the air.
Do not direct the flame at flammable material.
After the work is over, extinguish the flame by pressure relief valve.

Ensure that the length of the feather is 1.5 times the length of the cone.
Slightly pre-heat around the joint.
Colour change is restricted to dull red.
Melt and spread the filler rod around the joint with the use of the flux.
Apply the flame gently around the joint to make the filler metal penetrate in the joint.

Never apply a direct flame on the molten metal.
Add more filler rods around the joint, if needed.
Allow the joint to cool for a few seconds.
Clean the joint and inspect.
Repeat the same until you are able to make well-penetrated smooth silver-brazed weld.
Avoid overheating the joint.

• Adjust the soft carburising flame.

• Add more filler rods around the joint, if needed.
• Slightly pre-heat around the joint.
• Colour change is restricted to dull red.
• Ensure the use of all safety devices.
• Make a bell-mouth (Flare) at one end of the pipe and insert the other pipe in.
• Apply silver brazing flux along the root of the joint.
• Hold the joint in a vertical position in a bench-vice on a welding table.
• Set the gas welding plant with a small size nozzle.

Avoid overheating the joint.
Forming and soldering the sunk lap joint

Objectives: This shall help you to
• form a sunk lap using a hatchet stake
• solder the sunk lap joint.

Check the size, cut if required, and mark the allowance for sunk lap.

Sunk lap using the hatchet stake as shown in Fig 1.

Clean the surface to be joined by an emery paper.

Apply suitable flux and place two pieces as shown in Fig 2.

Heat the copper bit using a blow lamp as shown in Fig 1 of previous skill sequence.

Silver brazing of copper pipes by gas

Objectives: This shall help you to
• prepare the edges of copper tubes for bell-mouth butt joints
• silver braze copper tubes
• clean and inspect the silver-brased weld.

Copper tubes are mostly used in a number of fields such as automotive sheet metal trades, airconditioning and refrigeration.

Silver-brazing is the proper method to join the copper tube joints.

Cleaning and preparing the edges (Fig-1)

Clean the joining edges by rubbing with an emery paper or steel wool.

Use a steel rod to form bell mouth shape in one end of pipe and hammer around it with a mallet.

Setting the joint pieces (Fig 2)

Apply silver-brazing flux on the joining edges.

Set the joint pieces as bell-mouth butt joint maintaining alignment.

Hold the joint pieces in a vertical position in a bench nick Fig.3.
Never apply a direct flame on the molten filler metal or overheat the joint.

Add more filler rod around the joint, if needed.

Remove the flame and allow the filler metal cool for 10-15 seconds.

Cleaning and inspection (Fig 4)

Clean the joint by rubbing with an emery paper.

Inspect for a smooth and evenly filled, brazed joint without any pin-holes.

**Making silver brazing weld (Fig 3)**

Use a soft carburising flame, produced by nozzle No.1 a silver brazing filler rod Ø1.6mm (Type BA-Cu-Ag 16A conforming to IS: 2927 - 1975 ) and silver-brazing flux.

Heat around the joint to a dull red colour (melting of flux).

Apply, melt and spread the filler rod around the joint by scratching its end with the use of a flux.

Apply the flame gently around the joint and make the filler metal penetrate in the joint.
Make riveted lap and butt joint

Objectives: At the end of this exercise you shall be able to
• layout the spacing for rivet holes to make single riveted lap & butt joint
• punch the correct size holes using a solid punch
• rivet the snap head rivets with the help of rivet set, a rivet snap, a dolly using ball pein hammer, to make single riveted lap and butt joint.
• form the rivet heads of snap head and flat head rivets.

**TABLE**

<table>
<thead>
<tr>
<th>NO.</th>
<th>STEEL SIZE</th>
<th>MATERIAL</th>
<th>PROJECT NO.</th>
<th>PART NO.</th>
<th>EX. NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>IS:2155 - Ø3.5</td>
<td>M.S. SNAP HEAD RIVET</td>
<td>-</td>
<td>-</td>
<td>1.3.52</td>
</tr>
<tr>
<td>1</td>
<td>ISSH 140 x 48 x 1.2</td>
<td>MILD STEEL SHEET</td>
<td>-</td>
<td>-</td>
<td>1.3.52</td>
</tr>
</tbody>
</table>

**SCALE** 1:1

**SINGLE RIVETED LAP JOINT**

[Diagram showing dimensions and rivet positions]
Job Sequence

TASK 1: Single riveted lap joint

- Cut and check the given raw material to the size 140 x 48 mm using a steel rule.
- Flatten the sheet on the dressing plate by a mallet.
- Deburr the edges using a flat smooth file.
- Mark the centre line of length 140 mm and cut the sheet into two pieces of size 70 x 48 using straight snips.
- Layout the spacing for rivet holes to make single riveted lap joint using a scriber and a steel rule on both pieces of the sheet, and mark the centre points of rivet holes using a centre punch and a setting hammer. (Fig 1 & 2 of Skill sequence)
- Punch and make $\phi$ 3.2 holes on all centre points on one piece of the sheet and one central hole on another piece of sheet using a solid punch (Fig. 1)
- Deburr the holes with larger sized drill rotating it on drilled holes, by hand. (Fig 2)
- Place the piece of sheet having all holes punched above another, such that the overlapped edges of the sheets coincide with the marked lines.
- Insert 3 mm dia snap head rivet in the centre hole. (Fig.3)
- Form the rivet head, with the help of the rivet snap and dolly using ball pein hammer.
- Punch the remaining four holes on the bottom piece of the sheet, through the holes, already punched on the upper piece of the sheet.
- Deburr the holes with the larger sized drill, rotating it on the punched holes, by hand.
- Insert the rivets in alternate holes and form the rivet heads, one by one to make a single riveted lap joint, with the help of a rivet set, rivet snap, a dolly and a ball pein hammer.

TASK 2: Single strap single row riveted butt joint

- Cut the given material into three pieces, two to sizes of 50 x 48 mm and the third piece of size 24 x 48 mm using a straight snip and check the size using a steel rule. (Fig.1)
- Flatten the sheet on the dressing plate by a mallet.
- Deburr the edges using a flat smooth file.
- Layout the spacing for rivet holes to make single strap single riveted butt joint using a scriber, a divider and a steel rule on the pieces of sheets. (Fig.1)
- Mark the centre point for the rivet holes using a centre punch and a ball pein hammer.
- Drill $\phi$ 3.2 mm holes at all the points on the strap and the centre holes on the two workpieces to be joined.
- Deburr the holes with larger sized drill by rotating it on the drilled holes by hand.
• Butt the edges of the workpieces to be joined and place the strap over them and set it correctly as per the job drawing.
• Insert a φ3 mm flat head rivet in the centre hole of the butt pieces and strap rivet it using a rivet set, rivet snap and a ball pein hammer placing the job on the flat steel plate.
• Check whether the workpieces to be joined and the cover sheet are properly aligned on a marked line.

**Skill Sequence**

**Layout the spacing for rivet holes to make a single riveted lap joint**

**Objectives:** This shall help you to
- calculate the distance of the lap, the distance between centre of first rivet and edges and the distance of pitch as per BIS standard
- layout the spacing for rivet holes to make a single riveted lap joint.

Ensure the edges of the workpieces to be joined are free of burr and straight.
Calculate the distance of the lap.
Distance of the lap = 4 x Dia of the rivet (D)
Diameter of the rivet = 2.5 or 3times from the known thickness, calculate the dia of the rivet, and calculate the distance of the lap.
Mark the line of distance of the lap parallel to the edge, on both workpieces using a scriber and a steel rule. (Fig 1)

Calculate distance of the rivet line from the edge of the sheet.
Distance of the rivet line from the edge = 2 x the diameter of the rivet (D)
Mark the rivet lines parallel to the edge, on both workpieces (Fig 2).
Calculate the distance of the first rivets from the side edge.
Distance of the first rivet from the edge = 2 x dia of rivet (D)

Mark the distance of the first rivets from the side edges on the rivet line, on both the workpieces using a divider.
Calculate the distance between two rivets i.e. pitch.
Pitch = 3 x the dia of rivet (D)
Mark the pitch of the rivets on the rivet lines, on both workpieces (Fig 2) using a divider.
Punch on the centre points of the rivets using a centre punch and a ball pein hammer.

**Fig 1**

**Fig 2**

DISTANCE OF RIVET LINE FROM EDGE = 2D
DISTANCE OF FIRST RIVET FROM EDGE = 2D
DISTANCE BETWEEN TWO RIVETS (PITCH) = 3D
Riveting snap head rivet

Objective: This shall help you to
- make proper use of the dolly, rivet set and rivet snap to perform correct riveting
- form the rivet head in round shape, by applying the hammer blows properly by the ball pein hammer
- rivet snap head rivet to make the riveted joint tight without damaging the base metal.

Ensure that all the rivet holes are drilled on one sheet and only one hole for the centre rivet is drilled on another sheet. Ensure that the drilled holes are deburred and the sheets are flat.

Hold vice dolly rigidly in the bench vice.
Place the sheet having all holes drilled over the other, align the drilled hole and coincide the marked lines for lap with the edges.
Insert the rivet in the centre hole and place the rivet head on the vice dolly, to avoid deformation, while hammering. (Fig 1 & 2)

Remove the rivet set over the shank of the rivet. Form the rivet head roughly by hammering it down initially and then rounding the head using a ball pein hammer. (Fig 4 & 5)

Place the deep hole of the rivet set over the shank of the rivet. (Fig 3)

Strike the rivet set with a ball pein hammer to bring the sheets closer, to set the joint firmly for riveting. (Fig 3)

Place the rivet snap over the rounded head of the rivet and strike with a hammer over it to form and finish the rivet head using a ball pein hammer. (Fig 6)
Layout the spacing for rivet holes to make single strap single riveted butt joint

Objectives: This shall help you to
- calculate the breadth of a cover plate. Distance between the centre of first rivet and the edges and distance of pitch as per BIS Standard
- layout the spacing for rivet holes to make single strap single row riveted butt joint.

Ensure that the edges of the workpieces to be joined are free from burr and straight. First layout the spacing of rivet holes on the workpieces to be joined.

Calculate the dia of the rivet.
Diameter of the rivet (D) = 2.5 T or 3T, where T = Total thickness of sheets to be joined.

Calculate the distance of lap.
Distance of lap = 8 x D
Mark the line of distances of lap on both workpieces using a scriber and a steel rule. (Fig 1)

Calculate the distance of the rivet line from the edge of the sheet.
Distance of the rivet line from the edge = 2 x the diameter of the rivet (D).
Mark the rivet lines parallel to the edge on workpieces. (Fig.1)

Calculate the distance of the first rivet from the side edge of a butt.
Distance of first rivet from the side edge = 2 x dia of Rivet (D)
Mark the distance of first rivets from side edges on the rivet line, on the workpieces.

Calculate the distance between the two rivets i.e the pitch.
Pitch = 3 x dia of the rivet
Mark the pitch of the rivet on the rivet lines on workpieces using a divider. (Fig 1)

Punch on the centre point of the rivets using a centre punch and a ball peen hammer.

Layout the spacing of rivet holes on strap: Similarly, as mentioned above, mark two rows of rivet holes at a distance of 4D on strap Fig.2
Objective: At the end of this exercise you shall be able to
• solder the joints.

NOTE: USE EX.NO: 1.3.48 TASK 1
Job Sequence

Assembly of funnel and soldering

- Funnel body. (Fig.1)
  
  ![Fig 1](image1)

- Insert the ferrule (Part 3) in body (Part 1) and solder. (Fig 2)

- Flare 4mm edge of the larger dia 20mm end of the tail (Part 2) to position it securely in to the body.

- Insert the tail in the body (Part 2) and solder.

- Place and position the handle (Part 4) and solder as per job drawing.

- Inspect the finished article for sharp edges, burr or any irregularity and rectify if necessary.

- Wash the article with cold water.
Drill for riveting

Objectives: At the end of this exercise you shall be able to
• mark the drill holes as per drawing
• clamp and drill holes in sheetmetal for riveting using electric portable drilling machine.
Job Sequence

- Check the size of sheet 48x50mm using a steel rule.
- Flatten the sheet on dressing plate using mallet.
- Layout the spacing for drill holes and mark the centre points of drill holes using a centre punch and a ball pein hammer.
- Hold the sheet firmly using 'C' clamp.
- Drill Ø 3.2mm through holes as per drawing.
- De-burr the holes with larger sized drill by rotating it on the drilled holes by hand.

Skill Sequence

Drilling on sheetmetal by power operated portable drilling machine

Objective: This shall help you to
- drill correct sized hole on sheetmetal by operating power operated portable drilling machine properly.

Punch the marked centre points of the holes to be drilled lightly using a centre punch and a ball pein hammer.

Insert a straight shank, drill bit in the drill chuck of the portable drilling machine and tighten with the chuck key. (Fig 1)

Before inserting the drill in the drill chuck of the power operated portable drilling machine, be sure that the switch is off and earthing is provided.

Place the workpiece on a suitable wooden support and clamp with the help of a 'C' clamp. (Fig 2)

Hold the portable drilling machine in one hand and grasp the gun with fore finger and thumb of the other hand, such that the drill is perpendicular to the surface of the metal to be drilled. (Fig 2)

Switch ‘ON’ the trigger switch with second finger.

Apply pressure on the drilling machine till hole is drilled.

While drilling by electric operated portable drilling machine on a sheet metal, light pressure should be applied otherwise, the drill will get stuck to the workpiece. (Fig.3)

Switch off the drilling machine after the drilling is completed.

De-burr the holes by larger sized drill by rotating it on the drilled hole by hand.
**Objectives:** At the end of this exercise you shall be able to
- mark and drill hole for riveting as per drawing
- rivet counter sunk head rivet, flat head rivet, snap head rivet and pan head rivets.
RIVETING WITH MANY TYPES OF RIVETS
(SNAP HEAD AND PAN HEAD RIVETS)

TASK 3
SNAP HEAD RIVET

TASK 4
PAN HEAD RIVET

<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>
<th>TASK</th>
<th>TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ISSH 50 x 48 x 1.2</td>
<td>-</td>
<td>G.I SHEET</td>
<td>-</td>
<td>TASK 4</td>
<td>1.3.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ISSH 50 x 48 x 1.2</td>
<td>-</td>
<td>G.I SHEET</td>
<td>-</td>
<td>TASK 3</td>
<td>1.3.55</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Job Sequence**

- Check the size of sheets 50x48mm using a steel rule.
- Flatten the sheets on dressing plate using mallet.
- Mark and drill holes as per drawing.
- Place the piece of sheet having all holes drilled above another, such that the overlapped edges of the sheets coincide with the marked lines.
- Align the drilled holes in centre.
- Insert 3mm dia counter sunk head rivet in the centre hole. (Fig.1)

**Skill Sequence**

**Drilling machines and its parts**

**Objectives:** This shall help you to
- identify the types of drilling machine
- identify the parts of bench and pillar type drilling machine.

**The sensitive bench drilling machine**

The simplest type of sensitive drilling machine is shown in the figure with its various parts marked. This is used for light duty work. (Fig 1)

For normal drilling, the work surface is kept horizontal. If the holes are to be drilled at an angle, the table can be tilted.

Different spindle speeds are achieved by changing the belt position in the stepped pulley. (Fig 2)

This machine is capable of drilling holes up to 12.5 mm diameter. The drills are fitted in the chuck or directly in the tapered hole of the machine spindle.

**To form countersunk head rivet, pan head rivet, snap head rivet and flat head rivet, use dressing plate, rivet set, rivet snap and a ball pein hammer and complete the riveting.**
The pillar drilling machine

This is an enlarged version of the sensitive bench drilling machine. These drilling machines are mounted on the floor and driven by more powerful electric motors. They are used for heavy duty work. Pillar drilling machines are available in different sizes. (Fig. 3)

For drilling holes on materials, the drills are to be held accurately and rigidly on the machines.

The common drill-holding devices are drill chucks and sleeves and sockets.

Drill chuck

Straight shank drills are held in drill chucks. For fixing and removing drills, the chucks are provided either with a pinion and key or a knurled ring.

The drill chucks are held on the machine spindle by means of an arbour fitted on the drill chuck. (Fig 1)

Taper Sleeves and sockets (Fig 1)

Taper shank drills have a morse taper.

Sleeves and sockets are made with the same taper so that the taper shank of the drill, when engaged, will give a good wedging action. Due to this reason morse tapers, are numbered from 1 to MT5.

In order to make up the difference in sizes between the shanks of the drills and the type of machine spindles, sleeves of different sizes are used. When the drill taper shank is bigger than the machine spindle, taper sockets are used. (Fig 1)

While fixing the drill in a socket or sleeve, the tang portion align in the slot. (Fig 2) This will facilitate the removal of drill or sleeve from the machine spindle.

Use a drift to remove drills and sockets from the machine spindle. (Fig 3)
Workpieces to be drilled should be properly held or clamped to prevent from rotating along with the drill. Improperly secured work is not only a danger to the operator but can also cause inaccurate work, and breakage to the drill. Various devices are used to ensure proper holding.

While removing the drill from the sockets/sleeves, don't allow it to fall on the table or jobs. (Fig 4)

**Work - Holding devices**

**Objectives:** This shall help you to
- **identify the different work - holding devices.**

Workpieces to be drilled should be properly held or clamped to prevent from rotating along with the drill. Improperly secured work is not only a danger to the operator but can also cause inaccurate work, and breakage to the drill. Various devices are used to ensure proper holding.

**The machine vice**

Most of the drilling work can be held in a machine vice. Ensure that the drill does not drill through the vice after it has passed through the work. For this purpose, the work can be lifted up and secured on parallel blocks providing a gap between the work and the bottom of the vice. (Fig.1)
Workpieces which are not accurate may be supported by wooden pieces. (Fig 2)

Clamps and bolts
Drilling machine tables are provided with T-Slots for fitting bolt heads. Using clamps and bolts, the workpieces can be held very rigidly. (Fig 3) While using this method, the packing should be, as far as possible, of the same height as the work, and the bolt nearer to the work. (Fig 4)

There are many types of clamps and it is necessary to determine the clamping method according to the work. (Fig 5 & 6)
Striking and maintaining arc, laying straight - line bead

Objectives: At the end of this exercise you shall be able to
• set and operate an AC and DC arc welding plant
• set the welding current for the different sizes of electrodes
• strike and maintain the arc by scratching and tapping method
• deposit uniform straight weld beads and inspect for faults.
TASK 2

**Title:**
Laying Straight Line Beads by Arc Welding

<table>
<thead>
<tr>
<th>NO.</th>
<th>STOCK SIZE</th>
<th>SEMI-PRODUCT</th>
<th>MATERIAL</th>
<th>PROJECT NO.</th>
<th>PART NO.</th>
<th>EX. NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50 ISF 6-150</td>
<td>-</td>
<td>Fe310-O</td>
<td>-</td>
<td>-</td>
<td>1.4.56</td>
</tr>
</tbody>
</table>

**Scale:** 1:1

**Deviations:** ±0.5mm

**Time:** 1.5hr

**Code No.:** FIN1458E2

Capital Goods & Manufacturing - Fitter: Exercise 1.4.56
Job Sequence

**TASK 1 : Striking and maintaining arc**
- Check the size of the raw material.
- Mark and file to size.
- Clean the metal surface with a steel wire brush and wipe off the oil and grease if any.

**Dirt or rust makes poor connections.**
- Wear safety apparel (Protective clothing)
- Connect the welding cables with the machine and the job.

**Check the cables for damage and loose connections. Check whether the earth-clamp is properly attached.**
- Fix a ∅ 4mm M.S. electrode in the holder.

**Ensure the electrode is firmly held in the holder from the bare end.**
- Set the welding current (amperage) 140-150 amps.

**TASK 2 : Laying straight line beads by arc welding**
- Check the size of the raw material.
- Mark and file to size.
- Mark the bead position as per drawing.
- Set the work piece on the welding Table in a flat position.
- Set the arc-welding plant and connect the welding cables.
- Select and fix M.S. Electrode ∅4mm in the holder.

**Ensure that the electrode-holder JAWS are clean.**
- Set a welding current 140-150 amps on a AC or DC machine.

**If the power source is D.C. connect the electrode with the negative straight polarity.**
- Wear the complete safety apparel and check the filter lens of the welding screen.
- Strike the arc on a scrap piece for trial and observe the current setting.

- Strike the arc on the job-piece at one edge and maintain a uniform normal short arc.
- Move the electrode in a straight line and complete the bead at the other edge of the plate.
- During welding maintain a correct angle of the electrode at 70° - 80°.
- Arc length producing a steady sharp crackling sound.
- Travel speed approx. at the rate of 150mm per minute.
- Remove the slag from the weld bead and inspect for:
  - Uniform width and height - slag inclusion.
  - Normal depth of fusion.
  - Straightness.
- Repeat the exercise till you achieve good results.

If the welding machine is a D.C. one, connect the electrode to the negative.
- Start the welding machine.
- Strike and maintain the arc by the scratching method.

**Use a welding screen fitted with proper coloured glasses while arc-welding.**
- Hold a correct arc for a short distance and break by quickly withdrawing the electrode up.

**The correct arc burning will give steady, sharp, crackling sound.**
Repeat this exercise until the arc can be struck every time without the electrode freezing.
If the electrode freezes (sticks) to the plate, it should be freed immediately by a quick twist of the wrist motion to avoid overheating or spoiling. 
Skill Sequence

Setting of arc welding machine for welding

Objectives: This shall help you to
• set the arc-welding plant
• set the current according to the size of electrode
• strike and maintain the arc by the scratching and tapping method.

Striking an arc is a basic operation in arc welding. It will occur every time the welding is to be started.

It is an essential basic skill to learn in arc welding.

Setting of arc-welding plant (Fig 1)

Check the working of power source for the welding machine.

Remember electricity is a good servant but a bad master.

Call an electrician for solving any electrical problems.

Connect the welding cables with the welding machines.

Ensure that the cable connections are clean, dry, tight and are attached to the proper terminals of the machine.

Attach tightly the earth cable with the welding table at the proper place.

Keep the electrode-holder at a safe place.

If the machine is on DC power, connect the cables in correct POLARITY.

Setting a welding current

Set the welding current as per the diameter of the electrode to be used. (Table 1)

Select the electrode as per the thickness of the metal to be welded or as recommended. (Table 1)

Use alternative electrodes of nearest size in the case of non availability of the exact size of electrodes.

Table 1

<table>
<thead>
<tr>
<th>Thickness in mm (approx.)</th>
<th>Plate</th>
<th>Electrode</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Size mm</td>
<td>Range (amperes)</td>
</tr>
<tr>
<td>1.6</td>
<td>1.6</td>
<td></td>
<td>40-60</td>
</tr>
<tr>
<td>2.5</td>
<td>2.5</td>
<td></td>
<td>50-80</td>
</tr>
<tr>
<td>4.0</td>
<td>3.2</td>
<td></td>
<td>90-130</td>
</tr>
<tr>
<td>6.0</td>
<td>4.0</td>
<td></td>
<td>120-170</td>
</tr>
<tr>
<td>8.0</td>
<td>5.0</td>
<td></td>
<td>180-270</td>
</tr>
<tr>
<td>25.0</td>
<td>6.0</td>
<td></td>
<td>300-400</td>
</tr>
</tbody>
</table>

Striking and maintaining an arc

Scratching method (Fig 2)

Hold the electrode about 25mm above the job-piece at one end, perpendicular to the surface.

Bring the welding screen in front of your eyes.

Ensure safety apparel is worn.

Strike the arc by dragging the electrode quickly and softly across the welding job, using wrist movement only.

Withdraw the electrode approximately 6mm from the surface for a few seconds, and then lower it to (approx) 4mm distance.
If the arc has been properly struck, a burst of light with a steady sharp crackling sound will be produced.

Tapping method (Fig 3)

Strike the arc by moving the electrode down to touch the job surface lightly.

Move the electrode slowly up, approximately 6mm for a few seconds, and then lower it to approx. 4mm from the surface.

The tapping method is generally recommended as it does not produce pit marks on the job surface.

Straight line beading by arc (Flat position)

Objectives: This shall help you to
- deposit straight beads in a flat position
- clean the weldment and inspect for faults.

Job setting

Set the job in a flat position on the welding table. (Fig 1)

Ensure there is a good electrical contact between the job and the welding table.

Current setting (Fig 2)

Set the current on the welding machine, 140-150 amps for Ø4mm M.S. Electrode.

Always follow the current range chart for the electrodes in use.

Electrode position (Fig.3a&b)

Hold the electrode at an angle of 70° - 80° with the weld line and 90° with the adjoining plate surface.

Deposit straight beads by following the punched line and maintaining arc
- Correct arc length
- Correct travel speed
- Correct angle of electrode.
Ensure that the welding screen lens is clean so that you can see the arc and the weld line. Replace the plain glass, if spattered.

LISTEN to the arc. It produces a steady sharp crackling SOUND.

Adjust the travel speed by watching the electrode melting and flowing through the molten pool to form a deposited metal. (Fig.5a & b)

Remove the slag from the weldment using a chipping hammer and a wire brush.

Use goggles during slag removal.

Inspect the deposited beads and note any variations in the:
- Width and height
- Depth of fusion
- Length of run (Straightness)

Weldment Inspection (Fig.6)
Making square, Butt joint and ‘T’ fillet joint - gas and arc

Objectives: At the end of this exercise you shall be able to
• set and weld the workpiece to form a square butt and ‘T’ fillet joints in correct alignment in arc
• weld a ‘T’ fillet and square butt joint using recommended electrode, filler rod and nozzle size
• remove distortion from the joint
• clean the weldment and inspect for the surface defects.

TASK 1

**SQUARE BUTT JOINT IN FLAT POSITION BY ARC WELDING**
T' FILLET JOINT IN FLAT POSITION BY ARC WELDING
TASK 3

SQUARE BUTT JOINT IN FLAT POSITION BY GAS WELDING

<table>
<thead>
<tr>
<th>NO.OFF</th>
<th>STOCK SIZE</th>
<th>SEM/PRODUCT</th>
<th>MATERIAL</th>
<th>PROJECT NO.</th>
<th>PART NO.</th>
<th>EX. NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>ISSH 150 x 50 x 2.5</td>
<td>-</td>
<td>Fe310 - W</td>
<td>-</td>
<td>TASK 3</td>
<td>1.4.57</td>
</tr>
</tbody>
</table>

DEVIATIONS: ±0.5mm  TIME: 3h

CODE NO. F1457E1
Job Sequence

TASK 1: Square butt joint in flat position by arc welding

- Check the size of the raw material.
- Mark and file to size for square.
- Set the pieces on the welding table for square butt joint with 1.5mm gap in alignment. (Refer to drawing)
- Select a Ø 3.15mm M.S. electrode and set a 120 amps current.

Connect the electrode to negative, if the power source is D.C.

- Tack the pieces at both ends and also in the centre.

Ensure safety apparel is worn.

- Check the alignment of the tacked pieces, and reset, if necessary.
- Place the joint in a flat position on the welding table, well grounded. (Tacks side down - Refer skill sequence)
- Select a Ø 4.0mm M.S. electrode and set a 150-160 amps current.

Ensure the electrode angle is 45° with the corner and 70° to 80° with the welding line in the direction of travel.

- Deposit the first bead along the joint line with a:
  - Correct arc length
  - Correct electrode angle
  - Correct welding speed.
- Chip the slag from the bead, brush and inspect.

Use tongs to hold the hot job, chipping hammer and wire brush for chipping and cleaning, goggles for the protection of the eyes.

- Clean the back side of the first bead thoroughly and grind tacks flush.
- Deposit the second bead on this side, using the same settings.
- Chip the slag from the bead, brush and inspect for faults.
- Practice this exercise until you can produce a sound butt weld.

While but joint welding 1/3rd of gap to be maintained according to the thickness of plate or flat section of metal.

TASK 2: T' Fillet joint in flat position by arc welding

- Check the size of the raw material
- Mark and file to size
- Set and tack the job-pieces at both ends as 'T' fillet joint. (Refer to drawing).
- Ensure that a Ø 3.15mm electrode and a 130 amps current are used. Safety apparel should be worn.
- Clean the tacks, check alignment and reset the job, if necessary.
- Place the joint on a welding table in a flat position. (Tack side down - Refer skill sequence)
- Select a Ø 4mm M.S. electrode and set a 150-160 amps current.
- Deposit the first bead along the joint line with a correct and uniform
  - Arc length
  - Travel speed
  - Electrode angle.

Clean the weldment and inspect for faults.

- Clean the other side of the joint and grind the tacks flush.
- Set the joint in a flat position (weld side down).
- Make a second weld along the joint line with the same setting and technique as used for the first bead.

Clean the weld and inspect for the following weld characteristics.

- Smooth and close ripple appearance. Uniform width and height equal leg lengths
- Good fusion at the toe of the weld without undercut and overlap
- Leg length of the fillet weld equal to the plate thickness
- Repeat the exercise until you can produce good welds.
**Task 3: Square butt joint in flat position by gas welding**

- Check the size of the raw material.
- Mark and file to size.
- Set the job pieces on a welding table to form a square butt joint (open) with a root cap 1.5 mm.
- Set a gas welding plant, attach nozzles No.5 and set a pressure of 0.15 kgf/cm² for both the gases.
- Select a C.C.M.S. filler rod Ø1.5mm for tacking and Ø3.00mm for welding.
- Wear safety apparel.
- Set the neutral flame.
- Tack the pieces at both the ends and also in the centre using a Ø1.5mm filler rod. (Keep a shrinkage allowance of 2)
- **Tacks should be well fused and penetrated.**
- Check the alignment and gap between the pieces, and reset, if necessary.
- Clean the tacks and reset the job on the welding table in a flat position.
- Start welding, using the leftward technique with the correct angle of the blowpipe and filler rod of Ø3mm.
- Fuse the edges uniformly and add filler metal. (maintain a correct travel speed and motion of the blowpipe and filler rod, to produce a uniform weld bead)
- Stop at the left edge, fill the crater to complete the weld.
- Extinguish the flame, cool the nozzle and place the blowpipe at a safe place.
- Clean the welded joint and visually inspect for:
  - a slight convex uniform width and height of bead.
  - a slight penetrating bead on the reverse side of the ripples joint near the root.
- Repeat the exercise till you get good results.

**Task 4: Fillet weld ‘T’ joint in flat position by gas welding**

- Prepare job pieces as per drawing.
- Clean the surface and edges of the sheets to be welded.
- Set the sheets in the form of a ‘Tee’ joint on the gas welding table.
- Wear safety apparels and gas welding goggles.
- Set the gas welding plant, fix nozzle No.5 and set pressure at 0.15 kgf/cm² for both the gases.
- Set the neutral flame, tack at both ends of the joint and also in the centre with a 1.6 mm C.C.M.S rod.
- Check the alignment of the joint with a try square and clean the tacked portion.
- Keep the job on the welding table in a flat position.
- Start welding with the leftward technique and melt the right hand end of the joint.
- Fuse the area to be welded (i.e. equally the part of the horizontal sheet and the vertical sheet) and apply the filler rod in the molten pool to form a fillet weld at the joint.
- Maintain correct travel speed, manipulate the blowpipe and filler rod to produce a uniform weld bead.
- Stop the weld at the left hand end of the joint after filling up the crater at the end of the weld.
- Extinguish the flame, cool the nozzle and place the blowpipe at its place.
- Clean the weldment and inspect for defects in the fillet weld.

**Visual inspection**

- Slight convexity, uniform width, uniform ripples indicate a good weld bead. A weld without undercut, overlap, porosity, etc. will ensure a good quality weld.
- Weld on the other side of the joint for more practice.
Skill Sequence

Square butt joint by arc in flat position (TASK 1)

Objectives: This shall help you to
• weld a square butt joint in a flat position
• inspect the completed butt weld.

This type of joint is used very extensively in industry. If welded from both the sides (6 mm plate thickness), a sound weld can be obtained.

Setting and tacking
Set the pieces as butt joints with a 3 mm gap in a welding.
Tack at both the ends and one in the centre. (Fig 1)

Use a $\varnothing$ 3.15mm M.S electrode. Set the current 120-130 amps and length of the tack 15 mm.

Ensure the tacks are fused.
Check the alignment after tacking, and reset, if necessary (Fig 2).

Check the tack-welds thoroughly.

Welding butt joint
Place the joint in a flat position.
Deposit the first bead, using a $\varnothing$4mm M.S. electrode and 150-160 amps current with a correct:
• Electrode angle
• Travel speed, and
• Arc length. (Fig 3)

Move the electrode forward and backward along the line of the weld to
• Pre-heat the metal ahead of the weld
• Minimize the tendency to burn through
• Force the slag back over the top of the weld and control slag inclusion.

Inspection of the weld
Remove the slag from the weld and inspect for the following weld characteristics. (Fig 4)

• Width and height of bead should be uniform.
• Appearance should be smooth with close ripples.
• The face of the weld should be slightly convex.
• Edge of the welds should have good fusion, no overlap and undercut.
• The starting and stopping points should be free of depressions and high spots.
• The root of the weld and plate surface should have good fusion and penetration.
• The surface of the plate should be free of spatters.
‘T’ fillet joint by arc in flat position (TASK 2)

Objectives: This shall help you to
• weld ‘T’ fillet joint by arc in flat position free of distortion and weld defects
• inspect the fillet for weld characteristics.

The weld deposited on a 'T' or lap joint is called a fillet weld. Often the 'T'joint is called a fillet joint. (Fig 1) This joint is mostly used in industrial fabrication work.

Setting and tacking (Fig 2)
Set the pieces in alignment, forming a 90° 'T'. Tack the pieces at both ends.

Use ∅ 3.15mm M.S. electrodes. Set current at 150-160 amps. Ensure the tacks are well fused having a 15 mm length Check the alignment after tacking.

Welding a fillet joint
Place the joint for flat position welding. (Fig 3)

Hold the electrode, pointing at the corner of the joint at an angle of 45° to the plate surface. (Fig 4)

Incline the electrode 10°- 20° in the direction of travel. (Fig 5) Proceed to weld along the joint with a uniform travel speed. (Fig 5)

Watch the molten pool and freeze bead carefully for excessive build up or undercut (faults). Increase the speed or change the angle of the electrode to correct the above faults, if they appear.

Inspect the weld
Clean the weld thoroughly. Inspect the fillet for correct shape and size. No undercut and overlap at the toe of the weld. (Fig 6)
Leg lengths of the fillet almost equal to the plate.
Penetration of the weld complete to the root.
Face of the weld slightly convex.

---

**Setting up OXY-Acetylene plant (TASK 3)**

**Objectives**: This shall help you to
- set up the oxy-acetylene plant.

Move oxygen and acetylene cylinders with the caps from the store to the gas welding area. An oxygen cylinder is identified by the black colour painted on it. An acetylene cylinder is identified by the maroon colour painted on it. Also the oxygen cylinder will be taller than an acetylene cylinder and the diameter of oxygen cylinder will be less than the diameter of an acetylene cylinder. Ensure cylinders are kept separately from the empty cylinders. Position the gas cylinders in a trolley and secure them with a chain.

Always keep the cylinders upright/vertically in the cylinder stand/on the floor (Fig 2)

While moving, the gas cylinders should be kept slightly inclined to the vertical position and the protector cap used to avoid damage to the cylinder valves. (Fig 3)
Do not roll the cylinders horizontally on the ground.

Remove the cylinder caps. Crack the gas cylinder valves by quickly opening and closing them using the cylinder key. Fig 4

Dirt dust particles from the cylinder valve sockets are cleaned by cracking the cylinder valve. This will avoid leakage of gas due to improper seating of the cylinder valve and also to prevent the dust particles from entering into the regulators which may cause damage to the regulators.

Always stand opposite to the valve outlet while cracking the cylinders. (Fig 5)

Ensure that your hands are free from grease or oil.

Connect the oxygen regulator to the oxygen gas cylinder (righthand threads).

Connect the acetylene regulator to the acetylene gas cylinder (lefthand threads).

Ensure the pressure adjusting screws of both regulators are in a released condition.

Be sure to connect the correct regulator on cylinders, Acetylene connections have left hand thread and oxygen has right hand thread.

The acetylene regulator connecting nut will have a groove cut on it (Fig 6) and the pressure gauge dial will be of maroon colour.

All threaded connections should be fixed initially by tightening by hands and then only a spanner should be used. This will help to avoid assembly with cross thread leading to damage to threads.

Always use the correct size spanner to prevent damage to the threads (Fig 7)
It is dangerous to apply lubrications in the threaded assemblies of gas welding equipment as it can cause fire (Fig 8)

while tightening avoid undue force. The connections should be just tight.

connect the hose connector at the regulator end and the hose-protectors at the blowpipe end.

(use black hose for oxygen line and maroon hose for acetylene line.)

Acetylene connections have left hand threads with a cut on the corners of the nut while oxygen connections have right hand thread without a cut.

Attach one end of the black hose-pipe to the oxygen regulator outlet and the maroon coloured hose-pipe to the acetylene regulator outlet (Fig 9)

Secure the joints using hose-clips to ensure good grip and to avoid gas leakage (Fig 10)

Use a screwdriver to tighten the hose-clips.

Always use the correct size hose-clips (Fig 11)

Turn on the pressure adjusting screw of the regulator to which the oxygen hose pipe is connected (Fig 12)

Exert sufficient pressure to blow out dust or dirt particles if any are tapped inside the hose-pipe and then release the pressure adjusting screw.

Repeat the same for the acetylene hose also.

Attaching blowpipe

The other end of the hose-pipe is to be attached to the blowpipe inlets. (Fig 13)

Fix the hose-protectors at the blowpipe ends. The hose-protectors with a groove at the corners are fixed on the acetylene hose-pipe and connected to the acetylene inlet of the blowpipe. The hose-protectors without cutting marks are fixed on the oxygen hose-pipe and connected to the oxygen inlet of the blowpipe. (Fig 14)
The hose-protectors protect against the return flow of gas from the blowpipe to the rubber hoses. They act as non-return valves.

**Adjusting the gas pressure**

The gas pressure for both oxygen and acetylene has to be adjusted at regulators according to the size of the nozzle.

The size of the nozzle is selected according to the job material and thickness.

For adjusting the gas pressure, open the valves of both the cylinders slowly by one turn and set the pressure on both regulators as 0.15 kg/cm² for small size nozzles, by tightening the pressure adjusting screws. (Fig 15) Ensure the blow pipe control valves are kept open while setting the gas pressure.

The pressure can be read on the working pressure gauge of gas regulators.

---

**Testing for leakage**

All connections must be tested for leakage.

Apply soap water solution for acetylene connections and fresh water for oxygen connections (Fig 16).

Use of soap water on oxygen connections may lead to fire hazards.

Never use matches or flame light during leakage test.

**Lighting the flame**

Attach the recommended size of nozzle to the neck of the welding blowpipe i.e nozzle No.3.

Open the gas cylinders and adjust the recommended gas pressures on the regulators.

The pressure of oxygen and acetylene is 0.15 kg/cm² for nozzle no.3.
Open cylinder valves very slowly.
while setting pressure on the regulator, keep the blowpipe control valve open for accurate setting.
Open the acetylene control valve 1/4 turn on the blowpipe and ignite with a spark lighter. (Fig 17) Acetylene burns using the oxygen in the atmospheric air with a black smoke.

Avoid using any other source of fire other than the spark lighter.
Point the blowpipe in a safe direction in the open space, away from you and others.
Increase the acetylene till the black smoke disappears. (Fig 18)

Observe the flame and add oxygen by opening the oxygen control valve of the blowpipe. Now a bright white cone starts appearing at the tip of the nozzle (Fig 19)

---

**Fig 16**
Water and Oxygen

**Fig 17**
Acetylene burns using oxygen in the atmospheric air

**Fig 18**
No white cone
Acetylene flame in atmospheric air

**Fig 19**
White cone started appearing
Addition of oxygen
Square butt joint in flat position by gas (TASK 4)

Objectives: This shall help you to
- set and tack the workpieces in alignment for a square butt joint
- produce a uniform and well penetrated bead on an open square butt joint in a flat position
- visually inspect the completed joint.

The requirements of a good welded joints are:

The joint must be in correct alignment (distortion free)

The weld must be well fused, well penetrated, uniform in width and height, of correct size and free from internal or external faults.

Setting and tacking

Set and tack the job-pieces in correct alignment with a proper gap and for distortion allowance. (Fig 1)

Check the alignment after tacking, and reset, if necessary. (Fig 2)

Welding

Produce a well-fused uniform bead with complete penetration using a leftward technique (Fig 3) by;
- Holding and manipulating the blowpipe and filler rod in the recommended angles.
- Maintain a uniform travel speed and feed.
- Forming a correct size keyhole.

Finish the job.

Check alignment - remove distortion, if required, and inspect for:
Uniform width and height of weld bead in size. (Fig 4)
- Uniform ripples and fusion, complete penetration. (Fig 5)
- Absence of faults such as undercut, lack of fusion, unfilled crater etc.
Fillet weld ‘T’ joint in flat position by gas welding (TASK 5)

Objectives: At the end of this exercise you shall be able to
• set and tack the workpiece in alignment for a fillet weld tee joint
• weld a tee fillet joint using recommended filler rod and nozzle size
• visually inspect the completed joint.

‘T’ fillet joints are used extensively in industry i.e., fabrication of underframes, vertical supporters for oil and water containers and other similar structural work.

It is an economical joint with very little edge preparation but difficult to weld without defects (i.e. unequal leg length, undercut, etc.) unless the operator gets proper practice.

Root penetration must be obtained completely and undercut is to be avoided.

Setting and tacking the job pieces
Place the pieces on the welding table for Tee joint.
Hold the pieces in position using support. (Fig 1)

Ensure the vertical piece is perpendicular to the horizontal piece without gap of the joint.
Check with a try square for perpendicularity.
Tack-weld the joint at both ends (Fig 2) on one side of the joint.

Start welding at the right hand end of the joint by fusing the tack-weld and the parent metal to form a molten pool.
Keep the blowpipe in the leftward direction at an angle of 60° to 70° and the filler rod at an angle of 30° to 40° to the line of travel. The blow pipe and filler rod should be held at 45° between the 2 surfaces of the joint. This will ensure root penetration. Watch the molten metal closely to make sure that both pieces melt uniformly. Change the angle of the blow pipe if the pieces do not melt uniformly. When the molten pool is formed add the filler rod in the centre of molten pool. Give slight side-to-side movement to the flame (blowpipe) and a piston like motion to the filler rod.

Adjust the rate of travel of the blowpipe and the filler rod to secure even penetration at the root and into both sheets and to produce a fillet weld of equal leg length.

Welding of fillet ‘T’ joint in flat position (Fig.3)
Place the tacked joint in flat position by tilting and supporting it. (Fig.3)
Visual inspection (Fig 4)
Clean the weldment and inspect for:
- Uniform weld size and shape of bead (reinforcement and contour slightly convex)
- Equal leg length, no undercut at the toes of the weld
- No porosity, overlap

Fig 4
Setting up of flames, fusion runs with and without filler rod and gas

Objectives: At the end of this exercise you shall be able to
• set gas pressure according to the nozzle size
• select and fit the correct size nozzle according to the job thickness
• set job for flat position, weld fusion run with and without filler rod using leftward technique
• ignite, adjust and extinguish oxy-acetylene flame
• shut the oxy acetylene plant for stopping work
• clean the weldment and visually inspect for weld defects.
TASK 2

FUSION RUNS WITHOUT FILLER ROD IN FLAT POSITION BY GAS
TASK 3

FUSION RUNS WITH FILLER ROD IN FLAT POSITION BY GAS

<table>
<thead>
<tr>
<th>NO.OFF</th>
<th>STOCK SIZE</th>
<th>SEMI-PRODUCT</th>
<th>MATERIAL</th>
<th>PROJECT NO.</th>
<th>TASK 3</th>
<th>EX. NO.</th>
<th>PART NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ISSH 150 x 2.5-50</td>
<td>-</td>
<td>Fe310-W</td>
<td>-</td>
<td>3</td>
<td>1.4.58</td>
<td></td>
</tr>
</tbody>
</table>

SCALE: NTS
TOLERANCE: ±0.5mm
TIME: 4Hrs

CODE NO.: FIN1456E3

Capital Goods & Manufacturing: Fitter - Exercise 1.4.58
Job Sequence

TASK 1: Oxy - acetylene flame setting
- Wear safety apparel
- Open the gas cylinders and adjust the gas pressures on the regulators
- Open the control valve of the acetylene gas in the blowpipe
- Ignite the flame by using a spark lighter.

Avoid using any other source of fire
- Adjust the acetylene flow till the black smoke goes away
- Open the oxygen gas till a proper round inner cone is established without any sound in the flame. This is known as a neutral flame.

- Adjust the oxidizing flame by increasing the oxygen gas (with sharp inner cone and little hissing sound)
- Set the neutral flame again and adjust the carburizing flame by increasing the acetylene gas with the soft inner cone covered with an outer feather without any sound
- Repeat the setting of the flames till you manage to set the flame without any backfire or flash-back

Flame extinguishing and stopping work
- Extinguish the flame by closing the acetylene valve first and then the oxygen valve
- Dip the blowpipe nozzle in water to cool down by opening a little oxygen gas
- Close the cylinder valves and release all the pressure from the line

TASK 2: Fusion runs without filler rod in flat position by gas
- Check the size of the raw material.
- Mark and file to size.
- Mark the bead position as per drawing.
- Clean the surface
- Set the job piece on the welding table with the left edge raised about 15mm.
- Select and attach nozzle size 5 with a blowpipe (Indian Oxygen make)
- Set the acetylene and oxygen pressure at 0.15kg/cm² on the regulators.
- Wear safety apparel and set the NEUTRAL flame.
- Hold the blowpipe in position with the job at the right edge with the nozzle angle 60° - 70° with the welding line (marked with punches) nozzles angle 90° with the adjoining surface distance of the flame cone 1.5mm to 3.0mm from the surface, pointing leftward.
- Start heating and fusing the surface with a slight circular motion of the blowpipe.

Avoid excessive concentration of heat. If the metal becomes too hot, lift the blowpipe momentarily away from the molten pool.

Keep the molten pool in correct size by adjusting the rate of travel and the circular motion of the blowpipe.

- Stop at the left edge and lift the blowpipe quickly.
- Extinguish the flame and cool the blowpipe in water.
- Clean the fused surface with a steel-wire brush and inspect the uniformity of fusion runs.

If the speed of travel and the blowpipe motion are correct, the FUSION RUNS will appear in uniform width and even ripples.

- Repeat the exercise till you achieve uniform FUSION.

TASK 3: Fusion run with filler rod in flat position by gas
- Check the size of the raw material.
- Mark and file to size.
- Mark the bead position as per drawing.
- Set the workpiece on the welding table with the left edge raised about 15mm.
- Select the nozzles size 5 (IOL make-saffire type) and set the acetylene/oxygen pressure at 0-15 kg/cm².
- Select a mild steel copper coated (C.C.M.S) filler rod of Ø1.6mm.
- Wear safety apparel and set a neutral flame.
- Hold the blowpipe at an angle of 60° - 70° on a punched line of sheet and make a small molten pool at the right hand edge.

Keep a flame cone distance of 2.0 to 3.0mm from the job surface.
• Hold the filler rod in the left hand, pointing near the molten pool with an angle of 30°- 40° with the line of weld.
• Dip the end of the filler rod into the molten pool and add the filler metal on the job surface to form a weld bead.
• Move towards the left with a uniform speed along the punched line with a slight circular motion of the blowpipe and piston-like motion of the filler rod.

Add enough rod into the molten pool to build up the bead evenly in height and width. Coordinate the rate of travel with the filler rod to control the size of the bead and the required penetration.
• Stop at the left edge, extinguish the flame and cool the nozzle.
• Clean the weld surface. Inspect for even ripples and uniform width/height of the weld bead.
• Repeat the exercise till you get good results.

Skill Sequence

Ignite, setup and extinguish oxy-acetylene flame for gas welding (TASK 1)

Objectives: This shall help you to
• ignite, set and extinguish an oxy-acetylene flame for gas welding correctly
• shut the oxy-acetylene plant for stopping work.

Flame lighting
The safety apron, gloves and goggles are worn as shown in (Fig 1).

Set the pressure of oxygen and acetylene at 0.2kgf/cm² for a small size nozzle. (No.3)

While setting the pressure on the regulator, keep the blowpipe control valve open for accurate setting.

Open the acetylene control valve ¼ turn of the blowpipe and ignite with the help of the spark-lighter. Adjust the acetylene flow till the black smoke goes away. (Fig 2)

Avoid back fire or flash-back of blow pipe.

Flame adjustment
To adjust the neutral flame, add sufficient oxygen to make the white cone clear and round. (Fig 4)

The gas mixture from the blowpipe consists of oxygen and acetylene in equal volumes. To adjust the oxidising flame, add more oxygen.
Fusion runs without filler rod in flat position by gas (TASK 2)

Objectives: This shall help you to
• hold the blowpipe and flame in correct position to obtain proper fusion of metal
• make fusion runs without filler rod to produce uniform beads
• visually examine the quality of fusion beads.

Fusion runs
Homogeneous joints are produced in gas welding by melting and fusing the metal edges with the help of a gas flame.

The beginner in gas welding must practice the following steps correctly.

Fusing of a metal using a proper gas flame.
Holding the blowpipe in a correct position.
Fusion run in a straight line using the leftward technique.

Cleaning and setting the job-piece
Clean the job-piece surface with a steel-wire brush and emery paper.
Set the job-piece on a fire-brick welding table, raising the left edge app. 15mm. (Fig 1)

Extinguishing the flame
To extinguish the flame, close the acetylene valve (blowpipe) first and then the oxygen valve.

Shutting off the plant
At the end of the work, shut off the plant as stated below.
Close the acetylene cylinder valve.
Open the blowpipe acetylene valve and release all pressure.
Release the acetylene regulator pressure adjusting screw.
Close the blowpipe acetylene valve.
Repeat the above four steps for shutting off oxygen also.

Holding the blowpipe and flame in correct position for proper fusion.

Hold the blowpipe and flame in such a position that the axis of the joint is parallel to the operator’s body (Fig 2)

The angle of the nozzle with welding line 60°-70° (Fig.3) the fuse metal forms a small puddle on the molten pool on the job surface at the right edge (Fig 3) give a slight circular motion to the blowpipe.

Making fusion run without a rod
Move the blow pipe in a leftward direction as you get local fusion.
Keep the molten pool on the punch line. (Fig 4)

Maintain a constant speed of travel with a slight circular motion to the blowpipe. (Fig 5)

Maintain a constant 2-3mm of distance between the white cone of the flame and the sheet surface for a proper HEAT INPUT and avoidance of BACKFIRE.

**Fusion runs with filler rod on steel plate in flat position by gas** (TASK 3)

**Objectives**: This shall help you to
- make fusion runs with filler rod in a straight line using leftward technique
- clean and inspect the weldment for faults.

During gas welding, most of the joints require filler metal to obtain a proper, strong weld.

The feeding of the filler metal in the molten pool requires special skill, which is outlined here.

**Correct position of the blowpipe and filler rod.**

Hold the blowpipe and the filler rod in the correct position in respect of the job.

The blowpipe angle should be 60° - 70° with the weld line (towards right).

The filler rod angle should be 30° - 40° with the weld line (towards left). (Fig 1)

Keep the blowpipe and the filler rod at 90° to the plate surface. (Fig 2)

Fuse the metal surface and add the filler metal with proper motions; circular motion for the blowpipe, and piston-like motion for the filler rod. (Fig 3)

Maintain a flame cone distance from 2 to 3mm from the metal surface.
Direction of welding
Move the blow pipe in a leftward direction along as straight line to complete the weld. (Fig 4)

Maintain a constant 2-3mm of distance between the white cone of the flame and the sheet surface for a proper HEAT INPUT and avoidance of BACKFIRE.

Inspection of weld
Inspect the weld bead after cleaning properly with a wire brush, for a uniform width and height of the bead, uniform ripples, and proper depth of fusion. (Fig 5)
Butt weld and corner, fillet in arc welding

Objectives: At the end of this exercise you shall be able to
• bevel the plate edges by gas cutting for single vee butt joint
• grind the gas-cut bevel edges with proper root face for single Vee butt joint
• set the plates with a root gap of 2mm and proper distortion allowance for single Vee butt joint
• control arc blow
• deposit root run in single Vee butt joint to ensure complete penetration
• deposit intermediate and final covering runs in single Vee butt joint to obtain proper fusion and reinforcement
• clean and inspect the groove weld for surface defects and uniform root penetration.
FILLET WELD IN OPEN CORNER JOINT
IN FLAT POSITION BY ARC WELDING

TOLERANCE: ±0.5mm
TIME 10h

246 Capital Goods & Manufacturing : Fitter - Exercise 1.4.59
Job Sequence

**TASK 1 : Single ‘V’ butt joint in flat position by arc welding**

- Straight cut two 12mm thick plates by gas cutting as per drawing and grind them to size.
- Mark the bevel to 30° angle using bevel protractor in two plates.
- Punch witness marks
- Bevel the edges of each plate to 30° angle by gas cutting and file the root face as per drawing for edge preparation single ‘V’ Butt of joint. (Fig.1)

![Fig 1](image)

- Use a 3.15mm medium coated MS electrode and set 110 amperes current. In case of DC welding machine connect the electrode cable to the negative terminal of the machine.
- Tack weld on the back side of the plates at the ends. The length of tack should be 20mm.
- De-slag the tack weld and clean.
- De-slag and clean the root run and inspect root penetration.
- Position the tack welded job on the table in flat position (the single V portion facing up )
- Deposit the root run and fill the crater as done for welding square butt joint.
- Take special care to maintain key hole to ensure proper melting of root face and root penetration.
- Deposit the second run/intermittent run using 4mm medium coated electrode and 150-160 ampere current, short arc and proper weaving of the electrode. Avoid excessive weaving and ensure normal travel speed.
- Fill the crater wherever necessary.
- De-slag.
- Deposit the third run/covering run using the same parameter and technique used for 2nd run. Ensure a proper reinforcement of 1 to 1.5mm and avoid undercut.
- Inspect for any surface weld defect.

**TASK 2 : Fillet weld in open corner joint in flat position by arc welding**

- Prepare job plates to size as per drawing.
- Clean the joining edges and surfaces of plates.
- Set the plates as an open corner joint with a root gap of 2.5 mm using an angle iron jig.
- Select correct polarity, if a DC generator is used.
- Tack the joint pieces at both ends using Ø 3.15 mm medium coated MS electrode and 100-110 amps current from inside of the joint.
- Ensure safety apparels are worn. Use a proper method to control distortion.
- Clean the tacks, check alignment and reset the joint, if required.
- Set the joint on the welding table in a flat position.
- Deposit root run in the joint by forming a keyhole and obtain complete penetration.
- De-slag and clean the root run and inspect root penetration.

Ensure the crown of penetration is not more than 1.6 mm in height.

- Grind and dress the face of the root run, if required.
- Set the welding current 160 amps for Ø 4mm medium coated M.S. electrode.
- Deposit an intermediate layer i.e. second run over the root run with slight weaving motion using Ø 4mm electrode.
- Clean the intermediate layer thoroughly and inspect for faults. Rectify the defects, if any.
- Deposit the final layer to the weld size using the same current setting, electrode and weaving motion as used for the second layer.
- Clean the final layer for inspection.
- Inspect the corner fillet weld:
  - to ensure uniform and correct reinforcement
  - to ensure that the weld face is free from porosity, slag inclusion, unfilled crater, overlap and edge of plate melted off/insufficient throat thickness.
Skill Sequence

Single ‘Vee’ butt joint in flat position by arc (TASK 1)

Objectives: This shall help you to
• single ‘vee’ butt joint in flat position by welding
• prepare the plate edges for single vee butt joint
• set the plates with a root gap of 2mm and proper distorsion allowance for single ‘vee’ butt joint
• deposit root bead in intermediate and final covering runs in single ‘vee’ butt joint
• clean and inspect the weld for surface defects.

Preparation of the pieces (Fig 1)

Cut a 30° bevel on each pieces using oxy-acetylene cutting.
Grind the edges to remove oxide deposits on the bevel.
Prepare a uniform root faces of 1.5mm by filing on both the bevelled edges.

Setting the single Vee butt joint and tacking
Keep the bevel edges upside down with a root gap of 2mm, and 3° distorsion allowance. (Fig 2) using suitable support i.e. 1.5° on each side of the joint.

Tack-well on both ends. (20mm long)
Ensure safety apparels are worn.
Place the joint in flat position after tacking.

Deposition of root bead (Fig 3)
Deposit root bead using a Ø3.15 M.S. electrode and 110 amps welding current.
Proceed with a uniform normal speed holding a short arc.
Keep the electrode angle (as shown in Fig 3) at 80° to the line of weld.

Deposition of hot pass & caping beads (Fig 4)
Give a whipping motion to the electrode to maintain the size of the KEYHOLE for correct penetration.
Clean the root bead, and observe penetration.
Deposit the 1st covering bead using a 4.00mm dia medium coated M.S.electrode and 160 amps welding current.

Proceed with a uniform speed, holding a normal short arc and a side-to-side weaving motion to the electrode.

Ensure the electrode angle is the same as it was for the root bead.

Clean the bead thoroughly and grind the humps in beads (if present).

Rectify possible defects, if any.

**Deposition of final/caping bead (Fig 5)**

Deposit the final covering bead using a Ø5.mm M.S. electrode, 220 amps welding current, and imparting a wider side-to-side weaving motion to the electrodes. Pause (stop) the electrode weaving at the toes of the weld so that undercut defect will get eliminated.

**Cleaning and inspection**

Clean the welded joint thoroughly from both sides.

Inspect the weld size, surface defects, root penetration and distortion.

---

**Edge preparation**

**Objective:** This shall help you to
- types of edge preparation.

The preparation of edges are necessary prior to welding in order to obtain the required strength to the joint.

Joining edges are prepared for welding by one of the methods mentioned below

- Flame cutting
- Machine tool cutting
- Machine grinding or hand grinding
- Filing
- Chipping
Basic welding joints and position

Objective: This shall help you to
• types of welding joints and position.

The various basic welding joints are shown in Fig.1

The following are the important basic welding positions. (Fig.2)
Fillet weld in open corner joint in flat position by arc welding (TASK 2)

Objective: This shall help you to

• set and weld open corner joint

Setting and tacking plate pieces for open corner joint (Fig.1)

Set the plates as an open corner joint on the table with parallel root gap of 2.5mm throughout the joint. The angle between the plates is kept at 87° to control the distortion. The angular distortion is normally taken as 1° per run.

Check the alignment of the joint with a try square. (Fig.1)

Another method to control distortion is, set the angle at 90° and use a right angled iron fixture to minimise the distortion.Fig.3.

Tack weld the corner joint from inside using a MS electrode Ø 3.15mm and 100 - 110 amps current range. Tack weld at both ends with max tack length of 20mm each. (Fig.2)

Deposition of root run

Set the joint in a flat position.

Deposit root run in the bottom of the corner by

• using a M.S. electrode Ø 3.15 and welding current 110 to 120 amps.
• maintaining a slightly short arc
• positioning the electrode vertically between the edge and 60° - 70° with the weld line. Fig.4

Deslag and clean the tacks using chipping hammer and wire brush.

Ensure that the joining edges are perfectly clean and safety apparels are worn.

Capital Goods & Manufacturing: Fitter - Exercise 1.4.59

251
Ensure no slag particles are adhering on the root run. The crater is to be properly filled in each run.

**Deposition of covering layers**

Deposit 1st covering layer i.e., the second run using a Ø 4.00 mm medium coated MS electrode and 160 amps welding current. A weaving motion for the electrode has to be given to ensure enough metal is deposited in the groove and both edges of the plates are fused.

Ensure that the electrode angles are as shown in Fig.4. Uniform medium arc length, uniform normal travel speed should be maintained.

Clean the slag from the 1st covering layer thoroughly. Ensure all the surface defects are rectified.

**Deposit 2nd (final) covering layer i.e. the third run using:**

- Ø 4 mm M.S. electrode and 160 amps welding current
- wider weaving motion to the sides of corner joint
- a slower rate of travel that was done for the 1st covering layer.
- Use the same angle of electrode and arc length as used in 1st covering layer. Fig.4.

Each movement of the weave from one side to the other will deposit more metal, and that takes more time.

Ensure restarting and stopping of the beads correctly.

The usual defect on the final layer of weld is ‘edge plate melted off’. This can be eliminated if care is taken to weave the electrode to the required extent so that the edges are just fused. The arc should not be focussed on the edges at all.

---

**Inspection of fillet weld in corner joint** (Fig.6)

Clean the weldment thoroughly.

Check the angle between the plates for 90°.

Check each run/layer for the following weld characteristics.

Width and height: Uniform

Appearance: Smooth with close ripples.

Size: Full fillet without excessive reinforcement.

Face of welds: Root run and 1st covering layer flat, final layer slightly convex.

Edges of welds: Good fusion, no undercut, no overlap.

Starts and stops: Free of depression and high spots, craters filled.

Back side: Complete and uniform penetration. (Fig.7)

Surrounding plate surface: Free of spatter.
Gas cutting of MS plates

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

- mark cutting lines on the plate by keeping proper cutting allowance
- set the job for straight, bevel, circle and profile cutting
- select the cutting nozzle No. and the cutting oxygen pressure for different plate thickness
- adjust the preheating flame and preheat the metals
- cut straight line bevel, circle and profile by hand and machine
- clean the gas cut edges and inspect for defects.
OXY - ACETYLENE MACHINE CUTTING
(STRAIGHT, BEVEL, CIRCLE AND PROFILE)
Job Sequence

**TASK 1 : Oxy - acetylene hand cutting straight and bevel cut**

- Wear all safety clothing.
- Set the gas welding plant with a cutting blowpipe, and cutting oxygen regulator.
- Fit the correct cutting nozzle according to the thickness of the metal to be cut (for M.S. plate 10mm thickness use 1.2mm dia. orifice cutting nozzle)
- Adjust both oxygen and acetylene gas pressure according to the cutting nozzle size. (Oxygen 1.6 kgf/sq.cm and acetylene 0.15 kgf/sq.cm)

While adjusting the pressure keep the cutting blow pipe walls open

- Check the size of the raw material
- Mark and file to size 200x150x10
- Clean the plate from dirt, oil, grease paint, water etc.
- Mark gas cutting lines as per drawing.
- Punch witness marks on cutting lines
- Set the job on cutting table.
- Set the neutral flame.
- Wear the gas welding goggles.
- Hold the blowpipe at an angle of 90° between the line of cut and the cutting nozzle axis is between the nozzle and the surface of the plate.
- Heat one end of the punched line up to cherry red hot condition.
- Keep the distance between the workpiece and the tip of the nozzle about 5mm.
- Place the preheat cone approximate 1.6mm above the plate.
- Move the flame in circle a little larger than the tip size. When metal is heated to Cherry red, move the tip to the edge of the plate.

- Operate the cutting oxygen lever immediately and move the torch slowly along cutting direction.
- Maintain correct torch speed and distance between the plate surface and the nozzle up to the end of the cut.
- If long plates are to be cut, to get a good straight gas cut surface, clamp a straight edged flat parallel to the line of cut and use a spade guide attached to the cutting torch. Move the torch uniformly along the clamped flat and pressing the spade guide against the flat.
- On completion of the cut release the cutting oxygen lever and shut off the flame.
- Clean the cut surface by wire brush after chipping off any slag sticking to the cut edge.

**Making bevel cuts**

- The best method for obtaining a good bevel with a minimum slag is to cut and bevel at the same time.
- Mark and punch straight lines 25mm apart.
- For cutting a bevel keep one or two flats on the plates to be bevelled and angle the cutting nozzle by resting the nozzle over the flats.
- Hold the torch in left hand, light it, tilt it to 30-35° of the perpendicular.
- Preheat and start the cut holding the torch on both hands as done in straight line-cutting. Avoid kerf filling by increasing travel speed.
- On reaching the end, cutting should continue for another 6mm or more to get a complete cut.
- Shut off the torch at the end and dip it in water and chip off the slag.
- Repeat the exercise till a good and smooth cut is achieved.
- To bevel the edge of a long plate with a clean and good gas cut surface, use a bevelling attachment to the torch and tilt the nozzle of the torch to the required angle of bevel.

**TASK 2 : Oxy - acetylene machine cutting**

- Check the size of the raw material.
- Mark and file to size
- Mark the gas cutting linesaight bevel, circle and profile as per drawing.
- Punch witness marks on the gas cutting marked line.
- Set the cutting machine and connect the oxygen and acetylene cylinders, regulators to the hoses of the machine and fix a suitable cutting nozzle.
- Fit the circular and profile template on the cutting machine table.
- Clean the surface of the metal plate to be cut.

- Select and fix the nozzle as per the thickness of the plate to be cut.
- Clean the track on which the cutting torch assembly unit is mounted and the circular and profile templates and make sure that there is no dirt on them.
- Check the starting lever and ensure that it is in neutral position.
- Set the required pressure of oxygen and acetylene according to the size of the nozzle.
- Set the required speed in the speed control dial according to the thickness of the metal to be cut.
Skill Sequence

Oxy-acetylene hand cutting straight and bevel cut (TASK 1)

Objectives: This shall help you to
• set the gas cutting plant
• set the job for cutting
• adjust the cutting flame for gas cutting.

Setting the gas cutting plant: Set the oxy-acetylene gas cutting plant in the same way as was done for welding and connect the cutting blowpipe in the place of the welding blowpipe. (Fig 1) Also change the oxygen welding regulator with oxygen cutting regulator.

Adjusting cutting flame: Select the cutting nozzle and set the gas pressure as per the cutting job thickness. (Table 1)

The bevel thickness will be more for bevel cut, when compared with a square cut for same thickness.

- - - - - - - -

Fig 1

Fig 2

Capital Goods & Manufacturing : Fitter - Exercise 1.4.60
TABLE 1
Data for cutting

<table>
<thead>
<tr>
<th>Diameter of cutting oxygen orifice nozzle (1) mm</th>
<th>Thickness of steel plate (2) mm</th>
<th>Cutting oxygen pressure (3) kgf/cm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td>3.6</td>
<td>1.0 - 1.4</td>
</tr>
<tr>
<td>1.2</td>
<td>6.19</td>
<td>1.4 - 2.1</td>
</tr>
<tr>
<td>1.6</td>
<td>19 - 100</td>
<td>2.1 - 4.2</td>
</tr>
<tr>
<td>2.0</td>
<td>100 - 150</td>
<td>4.2 - 4.6</td>
</tr>
<tr>
<td>2.4</td>
<td>150 - 200</td>
<td>4.6 - 4.9</td>
</tr>
<tr>
<td>2.8</td>
<td>200 - 250</td>
<td>4.9 - 5.5</td>
</tr>
<tr>
<td>3.2</td>
<td>250 - 300</td>
<td>5.5 - 5.6</td>
</tr>
</tbody>
</table>

Acetylene pressure should be 0.15 kgf/cm² for all thickness of plates.

Select ø1.2 mm (orifice) cutting nozzle for cutting a 10 mm thick plate.

Set 1.6 kgf/sq.cm pressure for the cutting oxygen and 0.15 kgf/sq.cm pressure for the acetylene gas.

Ensure safety apparel is worn.

Fix the cutting nozzle into the cutting blowpipe correctly. (Fig 3)

Check for leakage in the blowpipe connections of oxygen and acetylene gas lines.

Adjust the neutral flame for preheating. (Fig 4)

Ensure that the flame adjustment is not disturbed while operating the cutting oxygen lever.

**Straight line cutting:** Keep the hand cutting blowpipe at 90° angle with the plate surface and start cutting a straight line. (Fig 5)

Preheat the starting point to red heat before pressing the cutting oxygen lever. (Fig 5)

Keep the distance between the workpiece and the nozzle about 5 mm to avoid backfire. (Fig 5)

Release the cutting oxygen by pressing the cutting oxygen control lever and start the cutting action and move the blowpipe along the punched line with uniform speed. (Fig 6)

Ensure straight travel without any side-to-side movement. The nozzle angle is 90° with the plate surface till the completion of cut.

Open the cutting oxygen valve fully.

If possible fix a straight edge or template to the plate and fix a support to the cutting nozzle so as to ensure constant distance between the tip of the nozzle and the plate surface and maintain a uniform straight cut. (Fig 7)

Inspect the cutting for
- uniform and smooth cut or drag line
- straightness, sharpness.
- width of the cut (Kerf) (Fig 8)
Bevel cutting: Set the job as shown in Fig 9. Hold the cutting blowpipe (nozzle) at (required) 60 - 55° angle so that the bevel angle on the plate will be 30 - 35°. (Fig 10)

There should not be any obstruction at the underside of the cutline and the parting piece from the job should be free to fall.

Preheat the starting point to cherry red colour.

Keep the distance between the workpiece and the nozzle about 5mm to avoid backfire. (Fig.10)

Release extra oxygen by pressing the cutting oxygen lever, observe the cutting action and start moving along the punched line with uniform speed. (Fig 11)

Keep less cutting speed than you would use for a straight cut for the same thickness.

Fix one or more straight bar to the cutting job to ensure the cut is along the straight line and also able to maintain the correct angle. (Fig 12)

Inspection of bevel cut: Clean the slag if sticking to the cut surface by a chipping hammer and wire brush and inspect for any gas cutting defects.

GOOD QUALITY is shown by excellent top edge and extremely smooth cut face. The cut part is dimensionally accurate. (Fig 13)
Oxy-acetylene machine cutting (straight, bevel, circle and profile)  (TASK 2)

Objectives: This shall help you to
• assembly of the portable cutting machine
• set the gas pressure to the size of nozzle
• cut the profiles by portable cutting machine.

The assembly of the machine, the use of templates or systems of reproduction, the position of the work, the speed range and cutting nozzles vary according to the type of the machines.

Assemble the accessorises like cutting head for straight and bevel cutting with the cutting machine. (Fig.1)

Select the 1.2mm size of the cutting nozzle for 10mm thick plate.

Set the correct gas pressure of 0.15kgf/cm² for acetylene and 1.4 to 2 kgf/cm² for oxygen for 1.2mm size nozzle.

Set the machine to run freely as per the regulated speed i.e 50cm/min for 10mm thick plate.

Ignite the flame and adjust the neutral flame.

Set the nozzle tip to a correct distance from the surface of the plate to be cut i.e. about 7 to 8mm.

Start the machine and run to the required distance to cut the metal.

Switch 'off' the machine and extinguish the flame at the end of the cut.

Remove the plate, clean the iron oxide slag and inspect the cut surface.

For cutting a bevel edge tilt the cutting torch nozzle to the required angle and follow the same skill sequence followed for straight line cutting. (Fig.2)

POOR QUALITY results in gouging which is a most common fault. This is caused either by excess speed or too low a preheat flame. (Fig 14)
Start the machine and run to the required distance to cut the metal.

Switch ‘off’ the machine and extinguish the flame at the end of the cut.

Remove the plate, clean the iron oxide slag and inspect the cut surface.

For cutting a bevel edge tilt the cutting torch nozzle to the required angle and follow the same skill sequence followed for straight line cutting. Fig 2.

For cutting a circle, attach cutting torch nozzle to the pivot block (Fig.3) and follow the same method used to cut straight line and bevel. It is important to pierce a small hole inside the circumference of the circle to be cut and then move the torch to the nearest point on the circumference. Then use the pivot block to move the flame along the circumference of the circle.

To cut a profile the same sequence used for circle cutting is followed except that a template similar to the profile to be cut is mounted on the table and a tracer attached to the cutting head will follow the template profile. The torch flame will cut the profile on the job.

Scan the QR code to view the video for this exercise